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COMMERCIAL FISHERIES REVIEW

A review of developments and news of the fishery industries
prepared in the BUREAU OF COMMERCIAL FISHERIES.

Joseph Pileggi, Editor
G. A. Albano and H. Beasley, Assistant Editors

Address correspondence and requests to the: Chief, Fishery Market News Service, U.S. Bureau of Commercial Fisheries, 1815 North Fort Myer Drive, Room 510, Arlington, Va. 22209.

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COVER: An unprecedented growth of the Soviet Pacific fishing fleet is taking place. During 1960-63, the Soviet Government added to that fleet over 200 modern fishing, fish-processing, whaling, and support vessels. Shown is a vessel of the Skryplev class. Designated a refrigerator transport, it is virtually a factoryship that can freeze fish and manufacture fish meal and oil. A distinctive feature of this vessel is a stern ramp fitted with a gate which can be closed.

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SOVIET FAR EAST FISHERIES EXPANSION

By Milan A. Kravanja*

ABSTRACT

Fisheries are today the most important industry in the Soviet Far East, an Economic Region encompassing all coastal provinces between Siberia and the Pacific. This prominence was achieved with the help of a generous investment program, which has resulted in greatly increased fishery landings. From 1950 to 1963, the production of fish and other aquatic animals rose by 313 percent to 1.5 million tons, an all-time record. This increase was accelerated during the last 4 years by additions of over 200 large modern fishing, fish-transporting, and fish-processing vessels. A large whale-hunting fleet was also created. The article describes 13 recently added Soviet vessel types in considerable technical detail. Statistical tables, maps, and photographs accompany the text.

BACKGROUND

Fishing is the most important industry in the Soviet Far East (fig. 1). In 1962 the value of the gross output from the Far East fisheries amounted to nearly 1 billion rubles (US$1.1 billion1/). This value was almost 30 percent of the value of the total industrial output in the Soviet Far East. The Far East fisheries are today a vast complex of fishing fleets, port facilities, and shore-based processing plants served by thousands of fishermen, longshoremen, and industrial workers. All is directed by a single regional administrative body, the Main Administration of Far East Fisheries.

Increased Soviet Far East fishery landings were made possible by a generous capital investment program. Like in all other Soviet industries, overall policy and programs for the fishing industry are determined by the central government in Moscow. The five-year plans for 1946-50 and 1951-55 allocated to the Far East Region nearly 35 percent of the total Soviet investment in the fishing industry--of the $1.3 billion provided during that 10-year period, the Far East received $461,000,000 (table 1). The seven-year plan for 1959-65 shows a striking increase in capital investment, with $2.2 billion allocated to the entire Soviet fishing industry; by 1965 the Far East will have received $728.7 million (or 33 percent of the total). The principal beneficiary of current increased investment outlays is the Maritime Province (Primorskii Krai), situated near Mainland China. This area's annual fishery investments increased from $8.9 million allocated during the 1951-55 5-Year Plan, to $69.4 million during the current 7-Year Plan, or by almost 700 percent.

Table 1 - Capital Investment in the Soviet Fishing Industry, 1946-55 and 1959-65

Region and Province	1959-65	1951-55	1946-50
	. . . . (Millions of US$)		
Far East Region:			
Primorskii Krai	485.2	44.6	27.9
Kamchatka Oblast' . . .	150.9	101.1	54.8
Sakhalin Oblast'	79.3	97.7	55.7
Other provinces	13.3	47.6	31.4
Total Far East	728.7	291.0	169.8
Other regions	1,506.6	545.2	322.3
Total U.S.S.R. . . .	2,235.3	836.2	492.1

Note: In converting Soviet internal rubles into U. S. dollars, the so-called official Soviet conversion rate of U.S.S.R. ruble 1.00 = US$1.10 has been used.
Source: Mikhailov 1962.

FISHERY ADMINISTRATION

Until 1959, the fishing industries of the Far East administrative provinces were controlled by local Economic Councils (Sovnarkhozes), as were other Far East industries. Lack

*Foreign Fisheries Specialist, Branch of Foreign Fisheries, U. S. Bureau of Commercial Fisheries, Washington, D. C.

1/In converting Soviet internal rubles into U.S. dollars, the so-called official Soviet conversion rate of USSR ruble 1.00 = US$1.10 has been used.

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of centralized control led to many difficulties. Exploratory fishing efforts, for example, were duplicated by provinces. Shore processing facilities were overloaded in one province, while installations in other provinces remained idle. The Far East fishing industry was reorganized at the end of 1959, and centralized control was given to a new organization--the Main Administration of Far East Fisheries (Glavnoe Upravlenie Dal'nevostochnoi Rybnoi Promyshlennosti, usually abbreviated in Soviet writings to Glavdal'vostokrybprom). The Main Administration, located at Vladivostok, is responsible to the Council of Ministers of the Russian Soviet Socialist Republic and to the Federal Committee on Fisheries, both in Moscow. This centralization has been found so effective in increasing production, that in 1962 the Soviet Union also reorganized its European-based fisheries into four major fishery administrations.

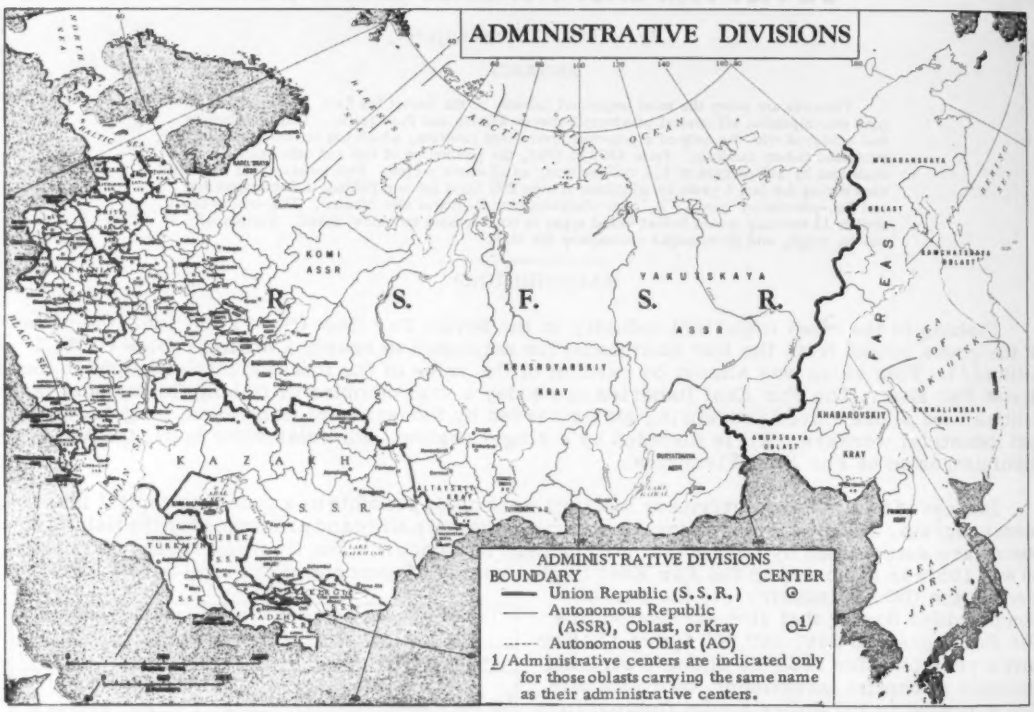

Fig. 1 - The Soviet Far East Region (Sovetskii Dalnii Vostok) is composed of 6 administrative units, 5 of which are contiguous to seas rich in fishery resources. It belongs administratively to the Russian Soviet Federative Socialist Republic (R.S.F.S.R.) which stretches from the Barents, Baltic, and Black Seas to the shores of the Sea of Japan, the Sea of Okhotsk, and the Bering Sea.

FAR EAST FISHERY CATCH

In 1963, the Far East Region produced about one-third of the total Soviet fishery landings of 4,670,000 metric tons (table 2). Official U.S.S.R. fishery statistics give a breakdown by Soviet republics, but the Russian Soviet Socialist Republic includes all major Soviet fishing areas and it is impossible to determine Far East marine landings from those figures alone. Analysis of current Soviet writings on economics, however, has supplied statistical data which are not publicly available from the Soviet Federal Committee on Fisheries (the equivalent of the U.S. Bureau of Commercial Fisheries).

Far East marine landings show significant changes since 1950, when about 370,000 tons were caught. By 1963, landings had increased fourfold to an estimated 1,530,000 tons. Soviet Far East landings have been expanding at a greater rate than total U.S.S.R. landings. In 1950

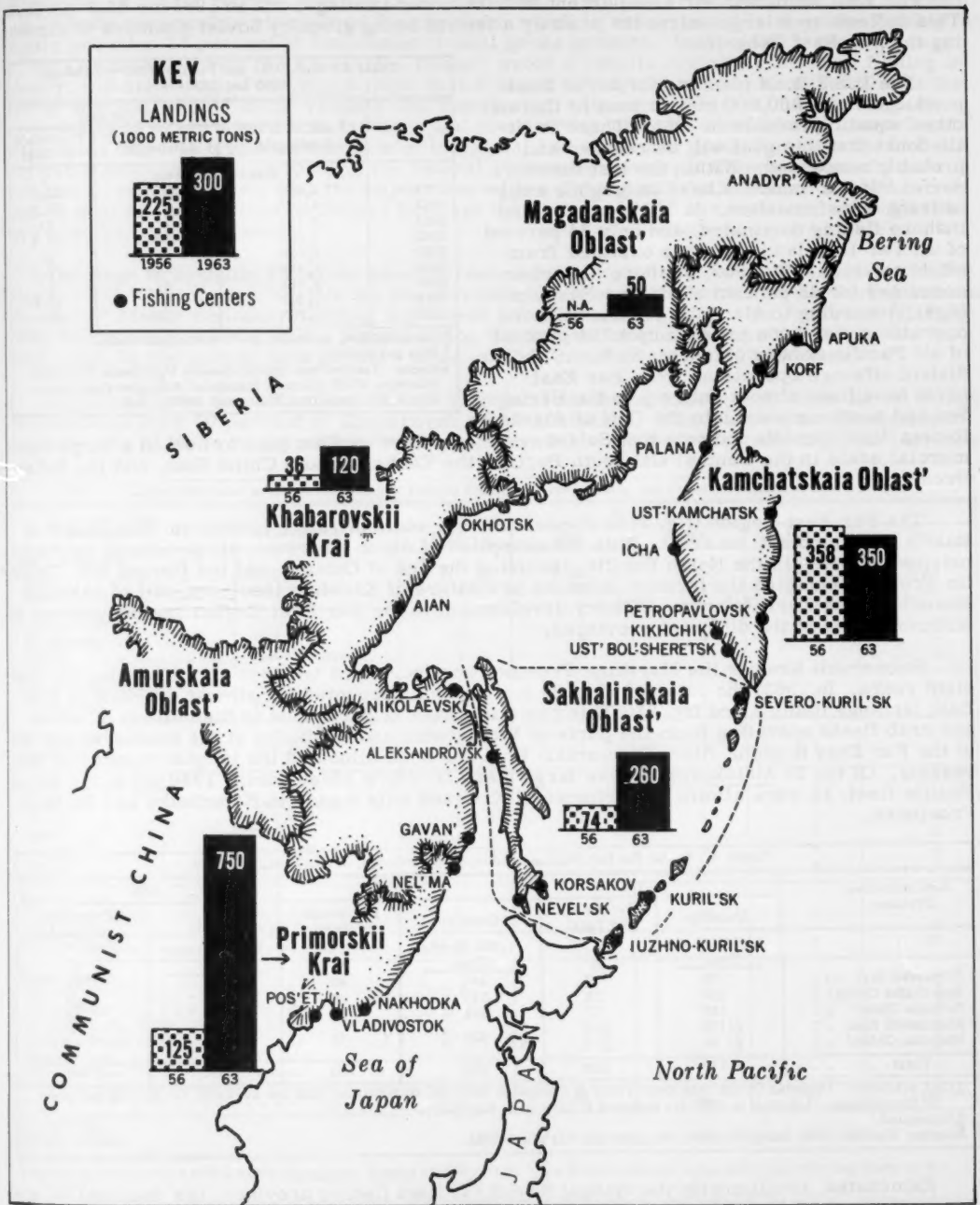

Fig. 2 - Soviet Far East marine landings, by provinces, 1956 and 1963.

the Far East accounted for 21.1 percent of total Soviet landings, and in 1963 for 32.8 percent. This reflects to a large extent the priority attention being given by Soviet planners to expanding the Far East fisheries.

Table 2 - U.S.S.R. and Far East Fishery Landings, 1950 and 1956-63

Year	Total U.S.S.R. Landings 1/	Far East	
		Landings 1/	Percentage of Total
	. . . (1,000 Metric Tons) . . .		%
1963	4,670	1,530	32.8
1962	4,167	1,203	28.9
1961	3,724	2/	2/
1960	3,541	860	24.3
1959	3,075	2/	2/
1958	2,936	846	28.8
1957	2,761	2/	2/
1956	2,849	593	20.8
1950	1,755	370	21.1

1/Includes fish, shellfish, and aquatic mammals.
2/Not available.
Sources: Tsentral'noe Statisticheskoe Upravlenie Pri Sovete Ministrov USSR (Central Statistical Administration of the U.S.S.R. Council of Ministers) 1963, 1964.

The U.S.S.R. is planning for a Far East production of 1,660,000 metric tons of fish and other aquatic products in 1965. There is little doubt that this goal will be reached and probably surpassed. Within the last decade, Soviet Pacific fisheries have undergone a significant transformation. In 1950, coastal and inshore fishing dominated, and only 34 percent of all Far East landings were obtained from offshore areas. By 1960, offshore fisheries accounted for 82 percent of all Far East landings. According to Margolin (1963), offshore operations may soon produce up to 94 percent of all Pacific fishery catches. So far, U.S.S.R. distant offshore operations from Far East ports have been almost entirely in the Bering Sea and southeastward into the Gulf of Alaska. Recent developments indicate that Soviet vessels in the Far East plan to fish on a large commercial scale in the Central and South Pacific, the East and South China Seas, and the Indian Ocean.

The Far East Region (fig. 2) is divided into six administrative provinces (designated in Russian as an oblast' or krai). With the exception of Amur Province, all provinces conduct marine fisheries in the North Pacific, including the Sea of Okhotsk and the Bering Sea. Sakhalin Province contains the former Japanese prefecture of Karafuto (southern half of Sakhalin Island) and the Kuril Islands. Fishery development in the Far East Region has progressed at different rates in the different provinces.

Primorskii Krai or the Maritime Province has increased landings sixfold during the last eight years. In 1963, the catch of 750,000 metric tons accounted for almost one-half of Far East landings (table 3 and fig. 2). This rapid increase is partly due to the buildup of whale and crab fleets operating from the ports of Vladivostok and Nakhodka at the southernmost tip of the Far East Region. Also, Primorskii Krai has been allocated the largest number of new vessels. Of the 21 Maiakovskii-class large stern trawlers added during 1960-63 to the Soviet Pacific fleet, 13 were allotted to Primorskii Krai and only 4 each to Kamchatka and Sakhalin Provinces.

Table 3 - Soviet Far East Marine Landings, by Provinces, 1956, 1960, and 1963

Administrative Divisions	1963		1960		1956	
	Quantity	Percentage of Total	Quantity	Percentage of Total	Quantity	Percentage of Total
	1,000 Metric Tons	%	1,000 Metric Tons	%	1,000 Metric Tons	%
Primorskii Krai . . .	750	49	344	40	125	21
Kamchatka Oblast' .	350	23	215	25	358	60
Sakhalin Oblast' . .	260	17	172	20	74	13
Khabarovsk Krai . .	2/120	2/ 8	{ 129	{ 15	36	6
Magadan Oblast' . .	2/ 50	2/ 3			1/	1/
Total	1,530	100	860	100	593	100

1/Not available. Magadan Oblast' was formed only in December 1953 and no statistical data are available for the first few years of its existence. Landings in 1956 are believed to have been negligible.
2/Estimated
Sources: Garfield 1959; Margolin 1963; Melnikov and Sal'nikov 1962.

Kamchatka, traditionally the richest Soviet Far East fishing province, has declined in relative importance. In 1956, about 358,000 metric tons (60 percent of Far East marine landings) were produced by that province. In 1963, production was about the same, but constituted only

23 percent of Soviet marine landings in the Far East. This has produced a certain restlessness among responsible officials of the province, which is understandable since the fishing industry provides 70 percent of Kamchatka's total gross product. In June 1963, the Secretary of the Communist Party for Kamchatka Oblast' wrote a caustic review of the local fishing industry, and stated that "one would think that it would be logical to keep Kamchatka in at the top of the list when fishing vessels are distributed. However, this is not so; they are sent mainly to areas where both landings and productivity are at a considerably lower level." Kamchatka imports 6 to 7 metric tons of industrial and consumer goods for each ton of fishery catch produced. Consequently, the central government wants to diversify Kamchatka's industries, and it is likely that the importance of her fishing will decline further. Nevertheless, a goal of 500,000 tons of fishery landings by the end of 1965 has been set, although this will probably not be reached.

Landings in Sakhalin Province have increased from 74,000 metric tons in 1956 to 260,000 tons in 1963. Mainly responsible for the increase has been participation in the Bering Sea and the Gulf of Alaska flounder, herring, and ocean perch fisheries, and intensified saury fishing (with electric lights and suction pumps) in the Northwest Pacific near the Kuril Islands. In 1963, over 70,000 metric tons of saury were landed; the 1965 goal is 200,000 tons.

Little is known about Khabarovsk and Magadan Provinces, except that Amur River salmon constitute over 10 percent of Khabarovsk marine landings. The low rate of investment in the fisheries of those two provinces is partly responsible for the reportedly nominal increase

Table 4 - Known Additions to the Soviet Far East Fishing Fleet, by Type, Class, and Country of Construction, 1960-63

Type and Class of Vessel	Country of Construction	Number of Vessels				
		1963	1962	1961	1960	Total
Medium trawlers:						
SRT	U.S.S.R.	2/	1/20	1/10	1/10	1/40
Okean	East Germany	4	3	4	3/ 5	16
Stern trawlers:						
Maiakovskii	U.S.S.R.	12	3	4	2	21
Tropik	East Germany	1	-	-	-	1
Motherships (herring):						
Severodvinsk	Poland	-	2	2	1	5
Factoryships:						
Zakharov	U.S.S.R.	2	1	1	1	5
Refrigerator transports:						
Bratsk	East Germany	1	3	4	-	8
Tavriia	U.S.S.R.	-	1	2	1	4
Pervomaisk	Denmark	-	-	1	1	2
Sevastopol	U.S.S.R.	2	1	-	-	3
Skryplev	Denmark	2	1	-	-	3
Whaling fleet:						
Sovetskaia Rossiia	U.S.S.R.	-	1	-	-	1
Vladivostok	West Germany	2	-	-	-	2
Catcher boats	U.S.S.R.	4/ 3	7	13	4	27
Support vessels:						
Tankers	2/	1	1	2	1	5
Repair ships	2/	2/	1	-	1	2
Floating docks, large	2/	2/	1	1	-	2
Floating docks, small	2/	2/	1	1	1	3
Salvage tugs	Finland	1	2/	2/	2	3
Water carriers	Finland	1	2	1	2/	4
Total		1/32	1/49	1/46	1/30	1/157

1/Estimated.
2/Not available.
3/Includes some 1959 deliveries.
4/Includes only catchers added to the Sovetskaia Rossiia whaling fleet. The Soviets operate three additional whaling fleets in the Pacific.
Note: Not included are smaller types of fishing craft, such as small and medium seiners, and vessels of the seal and walrus-hunting fleet.

in landings. From 1959 through 1965, the U.S.S.R. will have invested only the equivalent of US$13.3 million in the Magadan, Amur, and Khabarovsk Provinces. This is barely 0.6 percent of the total Soviet investment in the Far East fisheries (table 1).

FAR EAST FISHING FLEET

Increased Far East landings are mainly the result of an unprecedented growth in the Soviet Pacific fishing fleet. During 1960-63, the Soviet Government supplied the Main Administration of Far East Fisheries with over 200 modern fishing and support vessels--an estimated 500,000 gross tons. Data have been compiled from many sources on specific details regarding 157 of the larger vessels, totaling 410,020 gross tons. Table 4 gives the type and class of vessels built, the country of construction, and the year when the vessels were added to the Far East fleet. Table 5 gives the average and total gross tonnages of the new vessels.

Table 5 - Known Additions to the Soviet Far East Fishing Fleet, by Type, Class, and Gross Tonnage, 1960-63

Type and Class of Vessel	Average Gross Tonnage	Total Gross Tonnage				
		1963	1962	1961	1960	Grand Total
Medium trawlers:						
SRT	260	2/	1/5,200	1/2,600	1/2,600	1/10,400
Okean	505	2,020	1,515	2,020	2,525	8,080
Stern trawlers:						
Maiakovskii	3,170	38,040	9,510	12,680	6,340	66,570
Tropik	2,600	2,600	-	-	-	2,600
Motherships (herring):						
Severodvinsk	10,000	-	20,000	20,000	10,000	50,000
Factoryships:						
Zakharov	12,675	25,350	12,675	12,675	12,675	63,375
Refrigerator transports:						
Bratsk	2,500	2,500	7,500	10,000	-	20,000
Tavriia	3,230	-	3,230	6,460	3,230	12,920
Pervomaisk	3,300	-	-	3,300	3,300	6,600
Sevastopol	5,525	11,050	5,525	-	-	16,575
Skryplev	4,700	9,400	4,700	-	-	14,100
Whaling fleet:						
Sovetskaia Rossiia	33,150	-	33,150	-	-	33,150
Vladivostok	17,150	34,300	-	-	-	34,300
Catcher boats	850	2,550	5,950	11,050	3,400	22,950
Support fleet:						
Tankers	4,000	4,000	4,000	8,000	4,000	20,000
Repair ships	3,000	2/	3,000	-	3,000	6,000
Floating docks, large	2,500	2/	2,500	2,500	-	5,000
Floating docks, small	400	2/	400	400	400	1,200
Salvage tugs	1,000	1,000	2/	2/	2,000	3,000
Water carriers	3,300	3,300	6,600	3,300	2/	13,200
Total	-	136,110	125,455	94,985	53,470	1/410,020

1/Estimated.
2/Not available.

The additions to the Far East fleet in tables 4 and 5 were all vessels destined for distant offshore operations. Half of the 157 vessels specifically identified were medium trawlers (260 to 505 gross tons in size) and stern trawlers (2,600 to 3,200 gross tons); however, they accounted for only 21 percent of the gross tonnage. Motherships to store herring and factoryships to process fish and crabs were other important additions to the fleet. During 1960-63, known additions of motherships and factoryships to the Pacific fleet were 10, totaling 113,375 gross tons. The Soviets have recognized the need for all types of support to distant offshore fishing. Refrigerator transports, tankers, repair ships, floating docks, tugs, and water carriers give strong and vital support to fishing operations and the handling and processing of fish and shellfish. Nearly 40 such known additions, totaling 118,595 gross tons, were made to the Far East fishing fleet during 1960-63.

Major additions were also made to the whaling fleet. Three factoryships (totaling 67,450 gross tons) and 27 catcher boats (totaling 22,950 gross tons) were allotted to the Far East fleet.

The Soviets have relied on foreign shipyards for building a large part of their Far East fishing fleet. Of the known tonnage added to the fleet during 1960-63, an estimated 225,940 tons (55 percent) were constructed in the U.S.S.R. The remaining 184,080 gross tons were built in Poland (50,000 gross tons), West Germany (34,300 tons), East Germany (30,680 tons), Denmark (20,700 tons), Finland (16,200 tons), and unidentified countries (32,200 tons).

The trend in the Soviet Far East fisheries has been toward building vessels of larger tonnage. In 1960, the average gross tonnage of the 30 vessels added to the fleet was 1,782. The average tonnage increased each succeeding year--2,065 tons in 1961, 2,560 tons in 1962, and 4,253 tons in 1963. During 1960-62, medium trawlers were added in larger numbers. The sharp increase in average tonnage in 1963 can be attributed to the addition of 13 stern trawlers, compared with 9 during the previous three years; also, two new whale factoryships were added to the fleet.

Below are given descriptions of the classes of vessels added to the Soviet Far East fishing fleet during 1960-63. The data given are generally for the first vessel built in a class; subsequent additions to a class may have considerable modifications to improve efficiency of operation. Information is not available on the specifications of the whale catcher boats and support vessels assigned to the Far East fishing fleet.

MEDIUM TRAWLERS: During 1960-62, the following two classes of medium fishing trawlers (SRT--Srednii Rybolovnii Trauler) were added to the Soviet Pacific fishing fleet:

1. Without refrigeration (SRT): This class of medium trawler (fig. 3) is the most numerous of the fishing vessels in the Pacific offshore fleet. An estimated 500 to 600 SRT's participate in Soviet Far East fishing operations. Forty were delivered during 1960-62; data are not available on 1963 deliveries. SRT's have been constructed in the U.S.S.R.; they were also built in East Germany until 1959. The more recently built SRT's are about 260 gross tons in size, about 130 feet in overall length, carry a crew of 15, and have a cargo capacity of about 200 metric tons. The German-made SRT can only carry about 120 tons. In recent years, an estimated 50 SRT's were equipped with refrigeration plants and the ultimate plan of the Main Administration of Far East Fisheries is that all of its SRT's be refrigerated.2/

Fig. 3 - Trawler of SRT class. Vessel has no refrigeration equipment.

2. With refrigeration (Okean class): Built in East Germany, Okean motor vessels (also known as SRT-R or Srednii Rybolovnii Trauler Refrizheratornii) are conventional side trawlers, but also carry two boats for gill-net and ring-net fishing (fig. 4). Sixteen of these vessels were delivered during 1960-63. The vessels are 167 feet in overall length, 505 gross tons in size, and have a crew of 26. The fish caught (principally herring) are usually salted, packed in barrels, and stored in refrigerated holds at -4° C. (25° F.). The Okean-class vessels can work independently for 40 days at unlimited distances from shore; in the North Pacific, however, they are employed for months at a time as part of fishing fleets.

Equipment includes Soviet-manufactured radar, gyrocompass, radio-direction finder, and depth-determining echo-sounder (maximum depth 4,000 feet). A horizontal-vertical sounding

2/Communication by Mr. Winthrop A. Haskell, Fisheries Management Agent, Bureau of Commercial Fisheries, Juneau, Alaska.

apparatus of German manufacture is capable of locating fish schools at angles ranging between 150° to port and 150° to starboard from the ship's forward direction at a distance of 6,500 feet. A thermometer which can measure water temperatures down to 120 meters (394 feet) is also used to locate fish concentrations.

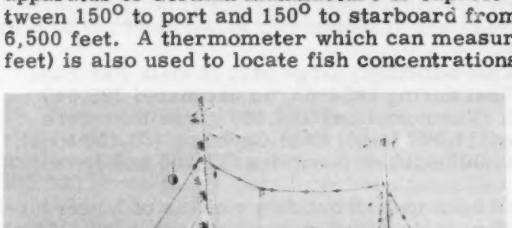

Fig. 4 - Trawler of Okean class. Has refrigerated holds. Vessel uses conventional side trawl, and is also equipped for gill-netting.

Trawling is done only over the starboard side with 2 power-driven drums each capable of hauling 1,200 meters (3,937 feet) of warp at an average speed of 60 meters (197 feet) per minute. The length of the warps indicates that the maximum depth at which an SRT-R can fish is about 1,500 feet.

Gill-net fishing is highly mechanized, the net being hauled by a powered pulley in the starboard bulwark; 2 grippers pass the net over a shaking device. A fish-salting and packing machine, capable of processing 4.5 metric tons of fish an hour, is installed on the main deck to reduce manual labor. Average yearly Soviet catches for Okean-class trawlers amounted to 690 metric tons in 1959 and 710 tons in 1960. In the Far East, however, average catches were larger; the best vessels caught up to 1,100 tons in 1962 and over 2,000 tons in 1963.

STERN TRAWLERS: One of the most significant classes added to the Far Eastern fleet during 1960-63 has been the stern trawler, also known as the BMRT (Bolshoi Morozilnii Rybolovnii Trauler or Large Freezer Fishing Trawler). Four classes of stern trawlers are operated by the Soviets--Pushkin, Maiakovskii, Leskov, and Tropik. All except the Leskov class have been used in the Soviet Pacific fisheries. The Maiakovskiis predominate (21 were added to the Far East fleet during 1960-63); only one Pushkin was delivered before 1960, and one Tropik in 1963. The stern trawler may well become the predominant type among Soviet fishing vessels, because it is a completely autonomous unit capable of fishing at great distances from home port and processing its catch.

The U.S.S.R. embarked on mass production of stern trawlers in 1958, after their prototype, the Pushkin (constructed in West Germany from the design of the British-built Fairtry), proved successful under high-seas conditions. BMRT's are more productive than conventional trawlers, and can produce catches of as much as 20 to 25 metric tons a haul (Gorinov 1962). The average yearly catch per fisherman on a BMRT has been reported as being 51.6 tons, on a medium side trawler 30.4 tons. Small Soviet coastal trawlers produced only 16.7 tons per fisherman. The cost of catching a ton of fish on a BMRT comes to 120.5 rubles (US$135.5), much less than on smaller Soviet fishing vessels (Melnikov 1962).

The characteristics of the BMRT stern trawlers added to the Far East fishing fleet during 1960-63 are:

1. Maiakovskii class--Improved versions of the Pushkin, Maiakovskiis (fig. 5) have a cruising range of 16,000 to 17,000 miles and can stay at sea 80 days, of which 60 can be spent on the fishing grounds. The vessels are 3,170 gross tons in size, 278 feet in overall length, and operate with a crew of 102. Maiakovskiis are being constructed in U.S.S.R. shipyards at Nikolaev (on the Black Sea) at the rate of about 12 to 24 a year.

Fishing equipment consists of a trawl and an electrically-driven winch for pulling

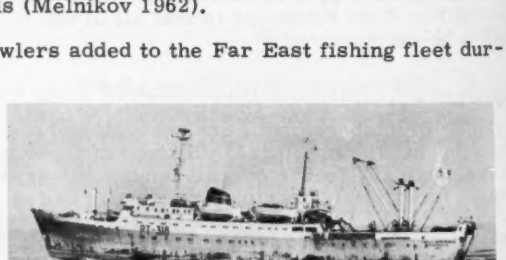

Fig. 5 - Stern trawler of the Maiakovskii class. Known also as a BMRT, the vessel is a completely integrated fishing and processing factoryship with freezing, canning, and reduction equipment.

in the trawl and bringing it up the stern ramp. The fish brought aboard can be frozen, canned, or reduced to meal and oil. Two automated lines are able to fillet 20 tons of fish a day; another line beheads (by machine) and guts (by hand) 10 tons of fish a day. Two twin-chute freezing chambers use an air system capable of delivering a temperature of -35° C. (-31° F.). The fillets or dressed fish can be quick-frozen to a temperature of -18° C. (-0.4° F.) in about 3 to 4 hours. After glazing and packing, they are stored at -18° C. (-0.4° F.) in refrigerated holds with a volume of 1,330 cubic meters (46,969 cubic feet). The canning plant--two autoclaves and one sealing machine--has a daily production capacity of 3,500 cans. Oil is removed from cod livers in a rendering shop equipped with two boilers. The fish-meal plant has two single-drum units which can process 20 tons of fish or offal per day; the fish-meal hold has a capacity of 170 cubic meters (6,000 cubic feet).

2. Tropik class--The newest type of stern trawler in the Pacific fleet has been designed primarily for diversified fishing in the tropics, although it can operate in temperate and subarctic waters. Basically a trawler, vessels of the Tropik class are also equipped with (1) three line haulers for tuna long-line fishing[3/]; (2) folding platforms along the sides of the vessel for tuna pole-and-line fishing; (3) two motor dories (each 30 feet in length) for purse-seining or line fishing; and (4) a fish-pumping plant for bringing aboard fish attracted to the vessel by electric lights. The vessel is equipped for experimental drift-net fishing. Tropiks can process catches by freezing, and can produce fish meal and fish oil from waste and offal and surplus fish.

Tropiks now have a crew of about 75; but by the time the last vessel in this class comes off the assembly line in 1965, further automation of equipment may reduce the crew to about 50 persons. The vessels are about 2,600 gross tons in size, 262 feet in overall length, and can stay at sea 60 days. Working and living quarters are air-conditioned. The refrigeration plant, consisting of 6 ammonia compressors, provides for (1) the freezing of 30 metric tons of fish in 22 hours; (2) cooling the holds to -25° C. (-13° F.); (3) producing 6 tons of flake ice in 15 hours; and (4) chilling 25 tons of fish a day from 30° C. (86° F.) to 2° C. (35.6° F.). Fish are dressed by hand and, after freezing, are packed in cartons stored in 3 refrigerated holds with a volume of 940 cubic meters (33,196 cubic feet). Processing equipment can handle 50 tons of raw fish a day--30 tons for freezing and 20 tons for reduction to meal and oil. Up to 3 tons of cod livers can be reduced to medicinal oil.

The Soviets have plans to assign 30 Tropiks to their Pacific fishing fleet. So far, only one, the Pegas, was delivered in July 1963 to the Sakhalin-based fishing fleet; during January and February 1964 it conducted exploratory operations for mackerel and jacks in the warm waters of the East China Sea. It also has fished for tuna in the South China Sea, in waters near the Indonesian coasts, and in the Gulf of Siam.

HERRING MOTHERSHIPS (Severodvinsk class): A herring mothership fleet consists of a large base ship (fig. 6) and a fleet of drifters or trawlers. Only trawlers have been reported operating in the Bering Sea. No processing is done on the mothership; the vessel is designed solely to receive and store the herring catches of fishing vessels. Immediately after being caught, the herring are salted lightly and placed in barrels before transfer to the mothership. The mothership provides the fleet with fuel, water, provisions, salt, barrels, and social and medical services.

Fig. 6 - Herring mothership of the Severodvinsk class. Alongside is a stern trawler of the Maiakovskii class.

The Soviet Union placed an order for 11 Severodvinsk-class motherships in 1959 with the state-owned shipyard at Gdansk, Poland. All were delivered by 1963, and 5 were allotted to the Far East during 1960-62, principally for operations in the Bering Sea. Each vessel is about 10,000 gross tons in size, and has a crew of 257. It has 5 refrigerated holds of

3/The use of three line haulers is not explained in the original Soviet source (Rybnoe Khoziaistvo, vol. 38, no. 8, August 1962, p. 37).

10,150 cubic meters (358,444 cubic feet), sufficient to store about 5,000 metric tons of fish. About 200 tons of lightly salted herring can be chilled each day and maintained at 0° C. (32° F.), assuring the good quality of this highly perishable fish. A helicopter, which can take off from a landing platform situated at the stern of the ship, aids in tracking schools of fish. The vessel's hull is strengthened for navigation in ice, a feature that also enables the mothership to withstand the striking of drifters or trawlers against the hull during loading or unloading operations. Eight fishing vessels, four on each side, can moor simultaneously alongside the 500-foot-long mothership.

FACTORYSHIPS (Zakharov class): The factoryship is designed to process fish and shellfish into finished products, as well as perform the service functions of a mothership. Although a variety of factoryships are operated by the Soviets in the Pacific, floating canneries were the only type of factoryship added to the Far East fleet during 1960-63. The Zakharov-class floating cannery (fig. 7) receives fish and shellfish from its fleet of SRT's (medium fishing trawlers) or from the 12 motorboats that it carries. The motorboats are of the Japanese kawasaki type, specially designed for catching king crabs with tangle nets, but they can be used for other types of fishing. Though designated a cannery, the Zakharov is also equipped to manufacture fish meal and oil from wastes obtained during canning operations.

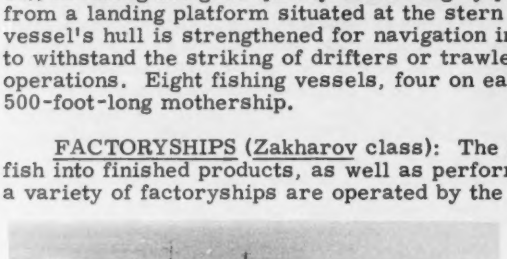

Fig. 7 - Factoryship of the Zakharov class. Alongside is an SRT trawler. The factoryship carries 12 motorboats for king crab fishing; two can be seen near the bow and stern.

Zakharov-class factoryships have been built at the Admiralty Shipyards in Leningrad since 1959. During 1960-63, 5 were delivered to the Far East, and it is reported that 3 more will be delivered in 1964. The vessels are 12,675 gross tons in size, 532 feet in overall length, and have a cruising range of 11,000 miles. Of the 640 people aboard, about 500 are processing workers and the rest are crew members. Processing equipment is capable of canning various species (e.g. herring, sardines, saury, ocean perch, and king crab), thereby enabling the factoryship to be used throughout the year. Automatic and semiautomatic machinery are consolidated into mechanized production lines. Daily capacity of the canning lines is about 1,600 cases, produced in three 7-hour shifts. About 2.4 tons of fish meal can be produced each day. Facilities are available for preparing caviar from salmon roe. The refrigeration plant is designed to (1) produce 25 tons of chipped ice each day, (2) cool fish in brine tanks, and (3) cool fish-storage and provision holds that have a total volume of 1,520 cubic meters (53,678 feet).

Considerable improvements have been carried out on recently constructed Zakharov-class factoryships. Reportedly, storage and ice production capacity have been doubled, and additional automation of production lines has made possible a reduction of 115 workers. The introduction of air-conditioning in the living quarters presages eventual deployment of those vessels in tropical fishing regions.

Soviet floating canneries are capable of remaining at sea independently for three months, but have been reported on Bering Sea grounds for as long as a year. In such instances, support vessels bring in supplies and transship finished products to Soviet ports. The Zakharovs have been observed during 1959-63 in Bristol Bay operating for king crab, and for a short time in 1963 in the western part of the Gulf of Alaska. The factoryships have also serviced vessels fishing for herring and ocean perch in Bristol Bay and saury off the Kuril Islands in the western Pacific.

REFRIGERATOR VESSELS: About 10 classes of refrigerator transport vessels have been used by the Soviet Far East fleet. The older classes act principally as refrigerator fish carriers (Refrizherator Rybnyi) and do not have equipment for quick-freezing fish. Construction of those classes has been discontinued. The newer classes, which are called production refrigerator transports (Proizvodstvennii Refrizherator), are designed to take fish on board at the place of capture, freeze them, and then deliver the frozen products to home ports.

The movements of the refrigerated and cargo fish carriers are controlled by the Administration of the Far East Refrigerator Fleet (Dal'Vostokrybkholodflot), headquartered at Vladivostok as part of the Main Administration of Far East Fisheries. The refrigerator transports are assigned to 11 operational units, each serving a Far East fishing fleet. In addition, an unknown number of cargo vessels transport salted herring in barrels.

At least 20 large refrigerator vessels were added to the Administration of the Far East Refrigerator Fleet during 1960-63. By 1963, a total of more than 70 refrigerator fish carriers were plying North Pacific waters, transporting processed, semiprocessed, and frozen fishery products from the fishing grounds to the mainland, thereby enabling fishing vessels to remain on the fishing grounds for long periods of time. The new additions to the Far East Refrigerator Fleet during 1960-63 were of the following five advanced classes:

1. Bratsk class--Eight refrigerator vessels of the Bratsk class were allotted to the Soviet Far East fleet during 1961-63. Those vessels--built in East Germany's Stralsund Volkswerft (Stralsund People's Shipyard)--are 270 feet in overall length, have a gross tonnage of about 2,500, carry a crew of 91, and can cruise for 40 days without replenishing supplies and fuel. The freezing and refrigeration plant consists of 2 freezer machines, 4 air-blast freezing tunnels, packing departments, refrigerating machines, and refrigerated holds. About 50 tons of fish--taken aboard fresh or iced from the catcher boats--can be frozen in a 22-hour period. Hold capacity of 1,800 cubic meters (63,566 cubic feet) permits storage of about 800 tons of frozen fish in cartons. Temperature in the holds is maintained at about -18° C. (-0.4° F.).

2. Tavriia class--Constructed in the Soviet Union, vessels of the Tavriia class (fig. 8) perform the same functions as those of the Bratsk class, taking aboard whole or gutted fish, quick-freezing them, and then conveying them to distribution centers on the Soviet mainland. Tavriias are 325 feet in overall length and 3,230 gross tons in size. Fish are frozen without further processing in two tunnel-type air-blast installations with a capacity of 50 metric tons per day. The fish are then placed in holds with a capacity of 3,300 cubic meters (116,539 cubic feet) at a temperature of -18° C. (-0.4° F.). In one hold the temperature can be lowered to -25° C. (-13° F). If the quantity of fish taken aboard exceeds the daily freezing capacity, 20 tons of fish can be preserved in flake ice and stored in coolers at 0° C. (32° F.). About 12 tons of flake ice can be produced each day.

Fig. 8 - Refrigerator transport of the Tavriia class. On board are facilities for quick-freezing and storing fish brought to the vessel by a fleet of fishing craft.

3. Pervomaisk class--Built for the Soviet ship-importing state enterprise (Sudoimport) by a Danish shipyard, Pervomaisk-class refrigerator vessels are 328 feet in overall length and about 3,300 gross tons in size. Air-blast freezer tunnels are fully automated. Further information on this class of refrigerator vessel is not available.

4. Sevastopol class--The largest refrigerator transports in the Soviet Far East fishing fleet are vessels of the Sevastopol class. Those vessels--430 feet in overall length and 5,525 gross tons in size--have been built at the Baltic Shipyard in Leningrad since 1961. Three were allocated to the Far East in 1962 and 1963. Sevastopols can freeze whale meat transferred from a whale factoryship, freeze fish without dressing them, and transport the frozen products to the Soviet Union.

The Sevastopol's freezing facilities, with a daily capacity of 100 metric tons of fish, consist of 8 air-blast freezing tunnels, each 39 feet long. Trays, each holding 33 to 40 pounds of fish, are loaded onto carts that are conveyed automatically through the freezer tunnels; the fish can be quick-frozen in 4½ hours. The frozen fish are removed automatically and stored

at a temperature of -18° C. (-0.4° F.) in five holds of 5,400 cubic meters (190,700 cubic feet) and a total capacity of 2,700 metric tons of fish.

5. Skryplev class--Although designated a refrigerator transport, Skryplevs (fig. 9) are virtually a factoryship that can freeze fish and prepare fish meal and oil. A distinctive feature of this transport is a stern ramp fitted with a gate which can be closed. Fish can be taken over the side direct from a fishing vessel or the vessel can leave its trawl bag floating on the surface of the sea. The bags are marked by buoys, usually fitted with radar reflectors; the transport's radar is used to locate the bags and they are brought aboard up the stern ramp. Three vessels of this class (built in Denmark) were allocated to the Far East fleet in 1962 and 1963.

Fig. 9 - Refrigerator transport of the Skryplev class. Besides freezing fish, meal and oil can also be prepared. The stern ramp is used to bring aboard trawl bags brought to the transport by fishing craft.

Skryplevs are 300 feet long between perpendiculars, 4,700 gross tons in size, and carry (excluding the actual crew) 102 people for handling and processing catches. For short-time preservation of fish, two ice-making plants can produce 10 tons of flake ice per day from sea water. The transport is fully equipped with fish filleting and heading machines, and has fish meal and oil plants capable of handling 30 tons of waste, offal, and surplus fish per day. Cod livers can be processed into medicinal oil in a special liver oil plant.

WHALING VESSELS: Due to the special nature of whaling operations, the Main Administration of Far East Fisheries has established a special Administration of Whaling Fleets, which is in charge of Far East whaling ships operating in the North Pacific as well as the one in the Antarctic. This Administration organizes timetables for tankers delivering fuel and taking on whale oil, and keeps records on the production of the fleets. On the whaling grounds, however, operational command and coordination with catcher boats remains with the captains of the whaling factoryships.

Soviet Pacific whaling operations predate the foundation of the city of Vladivostok, but were conducted for many years on a small scale from shore stations. In the late 1920's, a United States cargo vessel was purchased and converted into a whaling factoryship. Renamed the Aleut, it began operations in the North Pacific during the 1932/33 whaling season. Aleut operations were limited to the western North Pacific until 1959, when it began to hunt whales along the western Aleutian Islands. In 1962, the Aleut operated briefly off Kodiak Island in the Gulf of Alaska, possibly on an exploratory mission. In 1962 and 1963, major additions were made to the Pacific whaling fleet; 3 factoryships and at least 27 catcher boats were allotted to the Far East. All Soviet Pacific whaling vessels are based at Vladivostok or Nakhodka. The factoryship additions were as follows:

1. Sovetskaia Rossiia--A sistership of its prototype, the Sovetskaia Ukraina (assigned to the Atlantic fleet), the Sovetskaia Rossiia was constructed at Nikolaev on the Black Sea and joined the Far East whaling fleet in 1962. The vessel is about 33,150 gross tons in size, 715 feet in overall length, furnishes logistic support to 20 catcher boats, and is reported to be the world's largest whale factoryship. The Sovetskaia Rossiia has participated in Antarctic whaling each year since the 1962/63 season.

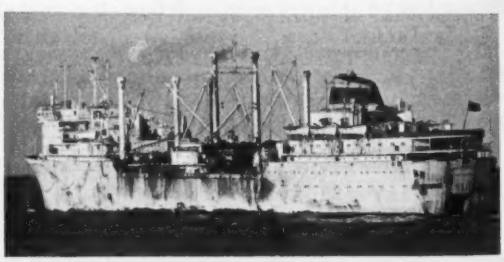

Fig. 10 - Whale factoryship of the Vladivostok class. The vessel is equipped for either whaling or fish processing.

2. Vladivostok class--In 1963, two newly constructed whale factoryships--the Vladivostok and the Dalnii Vostok--were assigned to the Far East fishing fleet. Constructed in West Germany, those vessels, each 596 feet in overall length and 17,150 gross tons in size, are equipped for either whaling or fish processing. The vessels (fig. 10) have a permanently installed whale factory, meal processing plant, and refrigerator tunnel. About 1,700 tons of raw whales can be handled daily by the whale factory to produce about 220 tons of oil, 200 tons of meal, 6.5 tons of vitamin oil, and 45 tons of frozen meat. When not whaling, a removable fish-processing plant is placed on the flensing deck; a daily quantity of 500 tons of raw fish can be processed into about 25 to 45 tons of fillets, 50 tons of frozen fish, 100 tons of fish meal, and 35 tons of fish body oil.

SUMMARY

The Soviet Far East Region, a geographical and economic rather than a political unit, includes all lands between Siberia and the Pacific. This Region extends over 3.6 million square miles or an area as large as the entire United States. Only about 5 million people, however, inhabit this huge land, which borders on Communist China to the South and on the Arctic Ocean and the Bering Sea to the North. The Soviet Government, anxious for the rapid economic and demographic development of such a strategically-exposed territory, is devoting large sums of capital to the build-up of the Far East economy.

Fisheries are the most important economic activity in the Soviet Far East, situated as it is on the vast and rich seas of the northwestern Pacific. The annual output of the Region's fishing industry, valued at nearly US$1.1 billion, represents about one-third of the value of the total industrial production of the Region. In 1963, the Far East produced over 1.5 million metric tons of fishery landings, or about one-third of the total Soviet landings of 4.7 million tons. In 1950, Soviet Far East landings had amounted to only 370,000 metric tons, which constituted a little over one-fifth of the total U.S.S.R. fishery landings that year.

This large expansion in production reflects the high priority which the central government in Moscow attaches to the rapid growth of the Far East fishing industry. Since 1946, well over one billion rubles (US$1.1 billion) have been allocated to the Far East provinces for the expansion of their fishing industry. Annual investments have increased steeply during the current 7-Year Plan (1959-1965) and represent approximately 1 percent of all Soviet industrial investments. The principal beneficiary of the current outlays is the Maritime Province (Primorskii Krai), whose yearly allocations increased eightfold in a decade. Most of the capital investments--currently up to about 75 percent--are spent on vessels. As a result, an unprecedented growth of the Soviet Pacific fishing fleet is taking place. During 1960-63, the Soviet Government added to this fleet over 200 modern fishing, fish-processing, whaling, and support vessels for an estimated gross tonnage of 500,000 tons. About one-half of that tonnage was constructed in domestic shipyards; the other half was purchased from Poland, West and East Germany, Denmark, Finland, and other countries. The trend in Soviet Far East fisheries has been toward building more processing and supporting vessels, vital for operating fishing vessels over long periods far from home ports or shore bases.

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Editorial Assistants: Ruth V. Keefe and Jean Zalevsky

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OVERALL VIEW OF SOVIET FISHERIES IN 1963, WITH EMPHASIS ON ACTIVITIES OFF UNITED STATES COASTS

By Loyal G. Bouchard*

ABSTRACT

The U.S.S.R. fishery catch has increased steadily in recent years, the result mainly of the expansion and integration of high-seas fishing fleets. The significant development is that Soviet fleets and vessels have developed the capability of fishing great distances from home ports. Those vessels now fish commercial fishery concentrations off the Atlantic and Pacific coasts of the United States. It is highly probable that Soviet fishing effort will increase in the Western Hemisphere, particularly in the western Atlantic, where the Soviets have made arrangements for the expansion, modernization, and use of a Cuban fishing port in Havana Bay.

INTRODUCTION

The fishery catch of the U.S.S.R. has more than doubled since 1950. Within the last decade, the Soviet Union has moved ahead of the United States to occupy fourth place among the leading fishing nations of the world. The large increase in the Soviet catch, which was already at a high level, is the result of expanded high-seas fishing operations. Fully integrated Soviet fishing fleets and large stern factory trawlers are now capable of fishing for prolonged periods at great distances from home ports. Such capability has enabled the Soviets to fish for commercial quantities of fish at the opposite sides of the Atlantic and Pacific Oceans. Soviet fishing fleets are now a common sight off the coasts of Alaska and New England, and Soviet fishing vessels also frequent the Gulf of Mexico, the Caribbean Sea, and areas off the Middle and South Atlantic coast of the United States.

CATCH AND PRINCIPAL SPECIES

Soviet Landings, excluding whales and other marine mammals, for selected years (preliminary estimate for 1963) reflect the remarkable progress and expansion of the Soviet fisheries.

Table 1 - U.S.S.R. Fishery Landings, 1950, 1955, 1960-63 1/

Year	Catch
	Metric Tons
1963	4,200,000
1962	3,616,500
1961	3,250,000
1960	3,051,000
1955	2,495,000
1950	1,627,000

1/Source: FAO Yearbook of Fishery Statistics, 1962.

Herring in 1962 comprised 24.5 percent of the Soviet catch, compared with 17.9 percent in 1955 (table 2). Cod and related species (including Alaska pollock) are also of major importance, and represented 24.4 percent of the Soviet catch in 1962. Catches of sprat, flatfish, and ocean perch have also increased significantly since 1955, whereas the catch of king crab has shown slight gains, and catches of Pacific salmon and fresh-water species

Table 2 - U.S.S.R. Catch of Fish and Shellfish, by Selected Species, 1955, and 1960-62

Species	1962	1961	1960	1955
	(1,000 Metric Tons)			
Marine:				
Cod, hake, haddock, and related species	783.8	669.7	563.3	686.0
Alaska pollock	97.2	97.6	109.2	9.7
Herring:				
Atlantic	500.7	396.7	523.4	224.4
Baltic	65.8	63.8	60.0	85.6
Pacific	320.5	272.8	193.0	135.9
Total herring	887.0	733.3	776.4	445.9
Sprat	270.0	234.0	199.8	177.2
Flounder, sole, halibut, and related species	238.7	273.1	241.7	127.2
Ocean perch	111.5	123.7	183.9	31.6
Salmon, Pacific	64.2	84.8	73.8	172.4
King crab	41.4	38.7	36.7	37.4
Other marine	758.7	574.8	434.6	237.6
Total marine	3,252.5	2,829.7	2,619.4	1,925.0
Fresh water 1/	364.0	420.3	431.6	570.0
Grand total	3,616.5	3,250.0	3,051.0	2,495.0

1/Principally roach, bream, carp, pike, pike-perch, and whitefish.
Source: FAO Yearbook of Fisheries Statistics, 1960 and 1962.

*Assistant Chief, Branch of Foreign Fisheries, U. S. Bureau of Commercial Fisheries, Washington, D. C.

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have declined. From 1961 to 1962, catch gains were noted for cod and related species, herring, sprat, and king crab, with declines in flatfish, ocean perch, and Pacific salmon. The Soviet catch of tuna reached 1,000 metric tons in 1962.

FISHING AREAS

A broad breakdown of the Soviet catch by area was based on an association between known species of fish and known bodies of water (table 3).

Table 3 - U.S.S.R. Fishery Catch by Area of Capture[1/], 1956 and 1962

Fishing Area	Catch	
	1962	1956
	. . . (Metric Tons) . . .	
Marine:		
Atlantic Ocean, Barents Sea, White Sea and adjacent waters	1,259,500	912,400
Pacific Ocean, Bering Sea, Sea of Okhotsk and adjacent waters	777,800	551,300
Baltic Sea, Sea of Azov, Black Sea, and Caspian Sea	356,100	394,600
Unidentified	859,100	268,700
Total marine	3,252,500	2,127,000
Fresh water	364,000	489,000
Grand total	3,616,500	2,616,000

1/Source: FAO Yearbook of Fishery Statistics, 1956 and 1962.

The Atlantic Ocean and adjacent waters supply over one-third of the total Soviet catch and continue to be of increasing importance. Large and increasing Soviet catches are also being taken in the Pacific Ocean and adjacent waters, particularly in the North Pacific and Bering Sea. The catch by major fishing area for 1956 and 1962 offers at best only a somewhat relative comparison; the data suggest that the catch from waters of the Atlantic Ocean area probably has increased by at least 38 percent since 1956, compared to a minimum catch increase from waters of the Pacific Ocean area of 41 percent. The catch in the "unidentified" category could not be further separated into the major marine fishing areas listed from the information presently available.

In the northwestern Atlantic Ocean, the Soviets are known to be taking significant quantities of ocean perch, cod, whiting (silver hake), haddock, herring, flounder, and halibut. Soviet catches, by principal species, taken in the ICNAF (International Commission for the Northwest Atlantic Fisheries) Convention area for the years 1956 and 1962-63 are given in table 4. In 1963, for the first time, whiting (silver hake) dominated the Soviet catch in the ICNAF Convention area, followed by herring, cod, and ocean perch. The herring and cod catches declined from 1962 to 1963. Soviet fleets now frequent the Grand Banks off Newfoundland and Georges Bank off New England. In August 1963, a peak number of over 200 Soviet vessels was reported operating on Georges Bank. In June 1963, a group of seven stern trawlers (BMRT class) was observed fishing for whiting (silver hake) in the vicinity of Bloc Canyon[1/], 30 miles south of Block Island, Rhode Island. The Soviet Union is also making a major effort to develop new fishing grounds in Davis Strait west of Greenland, and off the Labrador coast.

Table 4 - U.S.S.R. Catch in the ICNAF Convention Area, 1956, and 1962-63

Species	1963	1962	1956
	. . . . . (Metric Tons).		
Cod	81,658	100,791	3,001
Herring	100,036	160,404	1/
Whiting (silver hake) .	230,380	50,725	1/
Ocean perch	37,535	32,269	12,908
Haddock	6,504	5,315	1/
Other	35,333	20,290	1,100
Total	491,446	369,794	17,009

1/Included with "other."
Source: Documents of the International Commission for the Northwest Atlantic Fisheries (ICNAF).

In 1963, about 40 Soviet vessels, mostly medium trawlers and some stern trawlers, operated off the United States Atlantic coast from Nantucket Island south to Florida. In early 1964, about 30 Soviet medium trawlers were reported to be operating out of Cuban ports. In the past two years, some of those craft were observed off Virginia, the Carolinas, Florida, and Louisiana; it is believed those craft are conducting exploratory fishing operations and perhaps oceanographic studies off the Middle and South Atlantic coast of the United States, and in the Gulf of Mexico and Caribbean Sea. Species sought may include menhaden, shrimp, and tuna, among others. Soviet stern trawlers, operating off the coast of Virginia in March 1964, were taking scup, sea bass, and sea robins. In June 1962, a Soviet exploratory fishing vessel was reportedly seeking menhaden off the coasts of North and South Carolina. Soviet

1/A canyon in the ocean floor at approximately 39°42' N. latitude and 71°15' W. longitude.

scientists are known to be making a detailed study of the menhaden resources of the northwestern Atlantic; the study includes a thorough review of reports published on the subject in the United States. Soviet research vessels are also assisting the Cubans in an oceanographic study of the Gulf of Mexico.

In August 1962, it was announced that a Cuban fishing base, financed jointly by the Soviet Union and Cuba, would be built in Havana Bay. Reports indicate that construction at the base is proceeding rapidly and will include a shipyard for repairs, a large cold-storage plant, canneries, warehouses, and a fish reduction plant. The base will also be equipped with extensive docking facilities and will service about 130 Soviet fishing vessels as well as serving Cuban needs. The cold-storage plant will have a 10,000-ton capacity. In September 1963, about 2,000 workers were employed in construction at the base.

Some offshore marine resources of the western Atlantic, particularly off the coasts of Central American, South American, and Caribbean countries, are generally considered to be underdeveloped. Several Latin American countries do not have extensive fishery development capability and are not likely to develop such capability in the near future. In addition, the fisheries of the United States, Canada, and Mexico are highly selective, and certain species off the coasts of those countries are underutilized. Because of Soviet access to a Cuban fishing base and ports, Cuba's ideal location, Soviet fishing capability, and the underutilized state of many of the offshore marine fishery resources, the Soviets are expected to increase fishing efforts in the western Atlantic and adjacent waters in the future and further assist and encourage the Cubans in fishery development. In addition to the species mentioned previously, the Soviets may exploit stocks of flyingfish, anchovies, mackerel, swordfish, croaker, snapper, and other bottomfish and pelagic species available in sufficient quantity.

At least 400 Soviet vessels, at one time or another, fished on the high seas in the North Pacific and Bering Sea in 1963. Soviet catches in the North Pacific and Bering Sea include herring, ocean perch, flounders and soles, cod, Alaska pollock, sablefish, king crab, shrimp, and halibut. The halibut catches in the northeastern Pacific and eastern Bering Sea areas are believed small and incidental to trawl efforts for other bottomfish species. In October 1963, a Soviet research vessel reported taking good catches of halibut and sablefish in deep waters in the central Bering Sea area, but the exact location is not known. The Soviets are not known to be using baited multiple-hook and line sets for intensive commercial halibut fishing off Alaskan coasts as yet. Tangle nets are being used for king crab and in 1963, for the first time, the Soviets sought this species in the Gulf of Alaska, about 30 miles southwest of Kodiak Island. The Soviets first began trawling for ocean perch in the Gulf of Alaska in 1962. Meanwhile, Soviet exploratory fishing vessels were seen as far south, in the eastern North Pacific, as off the coasts of Washington, Oregon, and California. No data are yet available on the quantity of Soviet catch taken in the Gulf of Alaska. Catches of selected species in the Bering Sea are shown in table 5.

Table 5 - U.S.S.R. Catches of Selected Species in Bering Sea, 1960-1961 1/

Species	Catch	
	1961	1960
	(Metric Tons)	
Flatfishes	173,100	105,680
Herring	68,700	0
Ocean perch	48,500	11,700
Saury	24,440 (est.)	13,000
Other	14,700 (est.)	7,820
Total	329,440 (est.)	138,200

1/Source: Rybnoe Khoziaistvo, No. 10, October 1961.

The Soviets are also actively conducting fishing operations off the west coast of Africa and in the Indian Ocean. Soviet fishing craft have called at West African ports in Angola for supplies and fuel and the Soviets are assisting commercial fisheries development in Ghana. In mid-April 1963, the Fifth Soviet Tuna Research Expedition returned to Vladivostok from four months of exploration off the Chagos Archipelago in the western Indian Ocean. It is expected that commercial fishing operations will begin in that area in the near future for tuna, mackerel, and swordfish.

FLEETS AND VESSELS

The increased catch made by the Soviet Union is, for the most part, the result of high-seas fleet expansion with emphasis on increasing the number of larger motorized craft. In

1956, the Soviet fishing fleet numbered 60,443 craft, of which 12,387 were motorized and 48,056 were nonmotorized. In 1964, although precise figures are not available, the number of motorized Soviet fishing craft has increased significantly and could be as much as double the 1956 figure. The versatility and range of Soviet fishing fleets and vessels were also increased significantly.

The first Soviet stern trawlers were ordered in the mid-1950's and became operational a year or two later. Today, the Soviets have about 100 of those 2,600- to 3,200-gross-ton fishing vessels. The Soviets have also increased the number of medium fishing trawlers and seiners (250 to 600 gross tons each), as well as motherships, factoryships, and other fleet-supporting craft, but the total number is unknown. One Soviet herring fleet, operating off the Norwegian coast in April 1961, numbered more than 1,000 vessels. As mentioned previously, other Soviet fleets of 200 or more fishing vessels now frequent New England and Alaskan coasts.

The ocean-going fleets of the U.S.S.R. are highly versatile, mechanized, and integrated. Equipped with the most modern electronic fish-locating techniques and using a wide assortment of fishing gear, those fleets are capable of taking and processing commercial quantities of numerous pelagic and demersal species of fish in distant waters. Large floating factoryships and motherships produce canned, salted, and frozen fish and shellfish, and fish meal and oil, and are capable of remaining at sea for 60 days or more. Some are known to have remained at sea for as long as a year. Refrigerated carriers, cargo vessels, and transport ships haul to Soviet ports the catches processed by the factoryships and taken by the seine and trawl craft, and return with food, supplies, equipment, spare parts, mail, personal items, and replacement workers. Tugboats rescue disabled craft and repairs are often made on the high seas. Vessels comprising the large Soviet fleets are constructed in shipyards in the Soviet Union (in Western Europe and the Far East), East Germany, West Germany, Poland, Denmark, Sweden, Finland, and Japan.

FISH FARM ON LAKE HANKA, SOVIET FAR EAST

An expedition from the Pacific Institute of Fisheries and Oceanography has concluded several years of work on Lake Hanka, in the Soviet Far East.

The expedition studied the lake's flora and fauna, as well as hydrological conditions. The purpose of this research, the first of its kind there, was to study the conditions for artifical propagation and acclimatization of valuable varieties of fish.

Lake Hanka is one of the most interesting lakes in the world. It has about 60 varieties of fish, including fresh-water fish from cold northern latitudes as well as from the tropics, representatives of Asian fauna, and sturgeons from Russian European rivers.

A farm for the cultivation of the mirror carp will be built on the lake. It will be one of the biggest of its kind in the Soviet Union. (The Fishing News, June 26, 1964.)

SUPPLY, SUSTAINED YIELD, AND MANAGEMENT OF THE MAINE LOBSTER RESOURCE

By Robert L. Dow*

INTRODUCTION

Biological, environmental, and economic data have been assembled for presentation in the sequence of their relevancy to an understanding of the Maine lobster fishery and the resource which supports that fishery.

Specifically the data consist of landings statistics (tables 1, 2, 3, 11), annual average number of traps fished as an indicator of effort (tables 2, 11), average landed value (tables 3, 10), estimates of fishing and natural mortality rates from stratified sampling of catch (tables 4, 5), length-frequency measurements for estimates of recruitment rate (table 6), estimates of total available legal supply (table 7), and sea water temperatures recorded at Boothbay Harbor by the U. S. Fish and Wildlife Service (tables 8, 9, 11). Data are presented in terms of their inter-relationships.

The purpose is to demonstrate the use of biological, economic, and environmental information to (1) forecast relative abundance and available supply (tables 9a, 10a), (2) monitor changes in the population (tables 9, 10), and (3) recommend a type of management which would permit sustained annual yield of the fishery at or near optimum levels (table 14, fig. 5).

DISTRIBUTION AND LIFE HISTORY

The American lobster, Homarus americanus, the largest and commercially most important crustacean in Maine waters, supports the seventh most valuable United States fishery and brings the highest unit price of any major species in North America. These economic facts have been important considerations in appraising the biological condition of the resource and in predicting available abundance, both present and future.

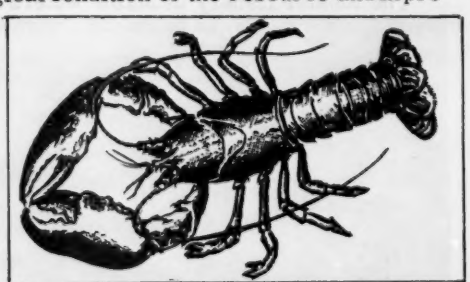

Fig. 1 - American lobster, Homarus americanus.

The lobster is especially abundant in Maine and Nova Scotia and occurs elsewhere in smaller numbers, both inshore and offshore, from Labrador to the Middle Atlantic.

At periodic intervals throughout life, varying with the rate of growth and commencing at the end of the first larval stage, the lobster moults. Although individual lobsters may moult at any season, for the majority this debilitating experience takes place sometime between May and September. In Maine there is a geographical variation; moulting occurs about six week earlier in western Maine waters than in the extreme eastern portions of the coast.

Shortly after moulting, while the new shell is soft, the mature female is impregnated by a hard-shelled male. Following approximately a year, the eggs are extruded from the ovaries and fertilized by the sperm which has been retained in the seminal receptacle. The fertilized eggs are attached in an adhesive mass to the swimmerettes under the tail. The number of eggs produced varies geometrically with the size of the female; the range reported from measurements at Boothbay Harbor (Taylor 1950) was from approximately 6,000 to 40,000 eggs for lobsters with a carapace from $3\frac{1}{4}$ to 5 inches. During the warm months of the following year the eggs complete incubation and hatch.

* Research Director, Maine Department of Sea and Shore Fisheries, Augusta, Me.

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The length of the larval period varies largely with sea water temperature from a minimum two weeks at 68°-70° F. to a theoretical maximum of approximately two months with low temperatures. Young lobsters become permanent bottom residents with the fifth larval stage.

Living on the ocean bottom, among and under the rocks and in burrows, and seeking shelter of rockweeds, kelps, and other marine algae, the lobster is a relatively sedentary animal, foraging at night but generally quiescent during daylight.

THE FISHERY

The record of 64 years of landings in table 1 shows the wide variation in production from 5 million to nearly 25 million pounds.

Table 1 - Maine Lobster Landings, Selected Years 1880-1963

Year	Millions of Pounds	Year	Millions of Pounds	Year	Millions of Pounds	Year	Millions of Pounds
1963	22.8	1947	18.3	1931	5.4	1906	15.0
1962	22.1	1946	18.8	1930	7.8	1905	11.1
1961	20.9	1945	19.1	1929	6.6	1904	12.1
1960	24.0	1944	14.1	1928	7.1	1903	13.1
1959	22.3	1943	11.5	1924	5.5	1902	14.3
1958	21.3	1942	8.4	1919	5.8	1901	14.0
1957	24.4	1941	8.9	1916	10.2	1900	14.4
1956	20.6	1940	7.6	1915	11.5	1899	12.7
1955	22.7	1939	6.6	1914	12.9	1898	12.3
1954	21.7	1938	7.7	1913	12.2	1897	11.2
1953	22.3	1937	7.3	1912	16.3	1892	17.6
1952	20.0	1936	5.1	1911	16.2	1890	20.0
1951	20.8	1935	7.7	1910	19.9	1889	24.5
1950	18.4	1934	5.4	1909	17.0	1888	21.7
1949	19.3	1933	5.9	1908	17.6	1887	22.9
1948	15.9	1932	6.1	1907	17.4	1880	14.2

The lobster fishery in Maine waters is carried on by means of pots or traps attached to buoyed lines--singly, in pairs, or on trawls. Pots or traps, similar to their probable progenitors (the creels fished in the waters of northwestern Europe and the British Isles), permit some selectivity, but in general, are inefficient. In terms of their return, the pots used require extensive capitalization. Traps or pots used alone represent about $10 million in time, labor, and investment. About the same amount is invested in boats, motors, and other equipment.

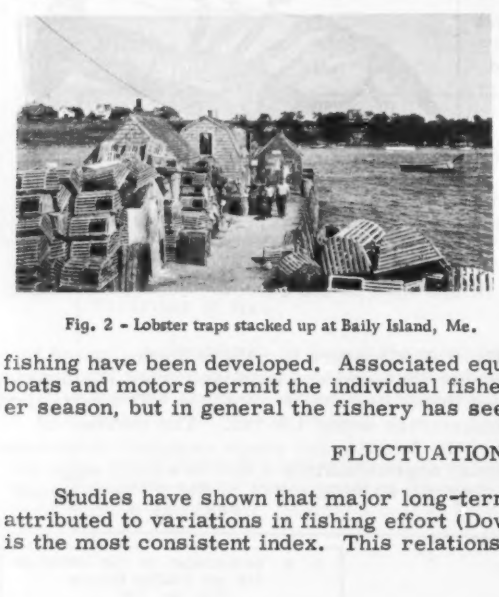

Fig. 2 - Lobster traps stacked up at Baily Island, Me.

The fishery in Maine waters began about 1843, primarily to supply canneries. There are reports of earlier use of the lobster resource for cod bait and for fertilizer.

Relatively few changes in the methods of fishing have been developed. Associated equipment such as depth recorders and improved boats and motors permit the individual fisherman to operate in a greater area and for a longer season, but in general the fishery has seen little change.

FLUCTUATIONS IN PRODUCTION

Studies have shown that major long-term fluctuations in Maine lobster landings can be attributed to variations in fishing effort (Dow 1961), of which the number of traps being fished is the most consistent index. This relationship is indicated by table 2.

Table 2 - Average Annual Fishing Effort (Units of Gear) and Total Annual Maine Lobster Landings for Selected Years

Year	Effort (Number of Traps)	Landings
	1,000	Millions of Lbs.
1924	154	5.5
1933	180	5.9
1937	186	7.3
1941	194	8.9
1897	234	11.2
1944	252	14.1
1902	298	14.3
1906	305	15.0
1950	430	18.4
1953	440	22.3
1955	532	22.7
1957	565	24.4

Table 3 - Average Annual Landed Value and Total Annual Maine Lobster Landings for Selected Years

Year	Landed Value	Total Landings for Years
	¢/Lb.	Millions of Lbs.
1934	16	5.4
1940	17	7.6
1941	18	8.9
1916	22	10.2
1943	26	11.5
1944	29	14.1
1947	37	18.3
1946	38	18.8
1945	41	19.1
1952	43	20.0
1956	44	20.6
1958	49	21.3
1962	51	22.1
1963	55	22.8

Short-term fluctuations are generally attributed to other factors, both economic and biological. The most important economic consideration is the price paid fishermen for their catch. The consistent influence of average price on lobster production is shown in table 3.

FEEDING AND GROWTH

Observations under natural, seminatural, and laboratory conditions indicate that lobsters eat both living and dead fish, mollusks, other marine invertebrates, and small quantities of marine plants.

The lobster is a comparatively slow-growing animal and is believed to be long-lived. Moulting depends upon growth and growth depends largely upon food intake. The frequency of feeding appears to be related to general activity which is influenced by water temperature. Post-moult feeding activity is high and is generally associated in Maine with seasonally high sea water temperatures. Those conditions concentrate the catch of lobsters in the five-month period, July to November, when about 75 percent of the annual catch is made.

Growth rates vary among individual lobsters. The frequency of moult varies and the actual growth increment made with each moult varies, although the average is about 14 percent in length and 50 percent in weight. From studies made in Maine (Taylor & Baird 1947, and Taylor 1949), it is likely that the most precocious lobsters in Maine waters reach minimum legal size when they are 4 years old. The number must be small and probably does not exceed 5 percent. The majority are believed to enter the fishery when they are 5 to 7 years old, while another small percentage may be 9 years of age or older before they reach minimum legal size.

Fig. 3 - A Maine lobster fisherman returns a sublegal lobster to the water.

MORTALITY

Stratified sampling of the catch supports the assumption that the resource is intensively exploited. A summary of those data arranged by moult-class groups is given in table 4. Natural and fishing mortality rate amounted to approximately 83 percent for recruits and 86 percent for the more catchable next larger (1st moult) size.

Table 4 - Total Lobster Mortality Rate and Percentage of Catch by Lobster Size Groups, 1949-1956

Carapace Size in Inches	Number of Lobsters Measured	Percentage of Catch	Percentage Decrease
		(%)	
3 1/16 to 3 1/2 (recruits)	239,537	84	-
3 5/8 to 4 1/8 (1st moult)	40,637	14	83
4 1/4 to 4 3/4 (2nd moult)	5,552	2	86
4 7/8 to 5 (3rd moult)	478	-	-
Total	286,204		

Table 5 - Natural Mortality

Carapace Size in Inches	Number of Lobsters	Percentage Decrease by 1/8-Inch or Three-Month Intervals
3 1/16	68,578	-
3 1/4	63,908	6.9
3 3/8	58,611	8.3
3 1/2	48,440	-

Natural mortality appears to vary, but probably ranges from about 28 to 33 percent a year, as indicated by the data in table 5. Estimates are based on assumed annual moult in which carapace linear increment is approximately 14 percent.

SUPPLY

Until about 1958 the supply of lobsters had generally been adequate to meet demand requirements. It is now becoming increasingly evident that nearly all of the available legal population is being caught each year.

Annual landings have averaged 22 million pounds for the past 13 years. Landings have fluctuated from 20 to 24.4 million pounds during that period. Sampling showed that 79 percent of the catch in 1947 was made up of previously sublegal lobsters that became legal as a result of moulting. By 1952, that number had increased to 85 percent (table 6) and by 1953 to 86 percent. Since that time, it has been estimated that the amount has gone as high as 90 percent or more in some years. Landings have increased approximately 3 percent in weight for each percentage increase in the number of recruits in the catch.

Table 6 - Fishing Effort, Landings, and Composition of Catch in Maine Lobster Fishery

No. of Traps	Annual Landings	Percentage Recruits in Catch
		%
365	17.5	
	18.3	79
	18.8	80
437	19.2	
447	19.4	82
	20.1	84
	21.4	85
464	22.0	86
560	22.3	
745	22.3	

To catch the remaining supply--that is, for the catch to consist entirely of previously sublegal, moult-recruited stock--would require an eightfold increase in fishing effort even if the resource could support such an intensive fishery.

Estimates, based on the 1947-1956 sampling, indicate that the annual available legal lobster supply has varied from 23 to 28 million pounds as a result of differences in the rate of growth and recruitment. During the period 1951-1963, the average available legal supply of lobster in Maine has been calculated to have been 26 million pounds, with a range from 25 to 28 million.

Table 7 - Estimated Maine Lobster Supply

Fishing Effort (Average No. of Traps)	Percentage Recruits in Catch	Average Annual Landings
1,000	%	Millions of Lbs.
928	87	22.5
1,220	89	23.5
1,604	90	24.0
2,109	92	25.0
2,773	94	26.0
3,646	96	27.0
4,793	98	27.5
6,300	100	28.0

From those data, estimates of future production at varying levels of fishing effort based on catch composition and sea water temperature conditions of the period 1947-1956 are shown in table 7.

SEA WATER TEMPERATURE

The influence of fluctuations in sea water temperature appears to be most pronounced during the spring prior to moulting and subsequent recruitment to the legal-size range. The

Table 8 - April (1)-May (2) Sea Water Temperature and July-August Maine Lobster Landings for Selected Years

Year	Temperature	Landings
	°F.	Millions of Lbs.
1953	50.0	8.1
1955	48.6	8.3
1954	48.5	8.1
1957	48.0	7.8
1952	47.6	7.1
1960	46.6	6.5
1958	45.8	6.0
1956	45.0	5.1
1959	44.8	5.3
1961	44.5	4.7

Note: Use of "April (1)-May (2)" is based on the assignment of 1 value of April sea water temperature to 2 of May.

relationship of temperature to catch at the beginning of the new lobster year is shown in table 8.

That temperature influences are largely seasonal is indicated by table 9.

Fig. 4 - Winter scene on the east side near the Boothbay Harbor freezer wharf.

Table 9 - Relation of April (1)-May (2) Sea Water Temperature and Maine Lobster Landings During Subsequent Periods, 1953-1963

Year	April-May Temperature	Landings						
		July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
	°F.	(Millions of Lbs.)						
1953	50.0	3.4	4.7	4.1	2.6	1.9	1.5	18.2
1955	48.6	2.9	5.4	4.8	2.8	1.9	1.1	18.9
1954	48.5	2.9	5.3	4.1	2.9	1.9	1.1	18.2
1957	48.0	3.0	4.8	4.5	4.0	2.6	1.6	20.5
1960	46.6	2.3	4.2	4.9	4.1	2.5	1.5	19.5
1963	46.3	2.1	3.5	4.1	4.3	2.5	1.6	18.1
1958	45.8	2.2	3.8	4.2	3.2	2.2	1.4	17.0
1956	45.0	1.3	3.8	4.5	4.1	2.3	1.4	17.4
1959	44.8	1.9	3.4	4.7	3.9	2.6	1.5	18.0
1961	44.5	1.6	3.0	3.7	4.0	2.5	1.9	16.7
1962	44.3	1.9	3.6	4.7	4.2	2.7	1.2	18.3

METHODS OF PREDICTING AVAILABLE SUPPLY AND LANDINGS

From the data in table 9, tables for predicting lobster landings, available supply, and relative abundance were constructed (table 9a).

Table 9a - Tables for the Prediction of Maine Lobster Landings; Assessment of Relative Abundance and Availability by the Use of Sea Water Temperature

April-May Sea Water Temperature	Landings in Certain Months						
	July	Aug.	Sept.	Oct.	Nov.	Dec.	6 Months Total
°F.	(Millions of Lbs.)						
50.0	3.4	5.3	4.1	2.6	1.9	1.1	18.4
49.0	3.3	5.3	4.1	2.8	1.9	1.1	18.5
48.5	3.0	5.3	4.1	3.0	2.0	1.1	18.5
48.0	2.9	4.8	4.2	4.0	2.5	1.5	19.9
47.5	2.5	4.5	4.2	4.0	2.5	1.5	19.2
46.5	2.3	4.2	4.2	4.1	2.5	1.5	18.8
46.3	2.2	3.8	4.2	4.2	2.5	1.5	18.4
46.0	2.2	3.8	4.2	4.2	2.5	1.5	18.4
45.0	1.9	3.8	4.5	4.2	2.5	1.5	18.4
44.8	1.9	3.4	4.7	4.2	2.6	1.5	18.3
44.5	1.7	3.2	4.7	4.2	2.6	1.6	18.0
44.3	1.6	3.2	4.7	4.2	2.7	1.6	18.0
Standard Error	±11.45%	±5.95%	±9.90%	±7.76%	±4.90%	±14.31%	±4.04%

Unfortunately the tables do not include available supplies and landings during the first six months of the calendar year, nor do they account for variations in fishing effort associated with differences in seasonal price paid fishermen for their catch.

The influence of supply on landed value and of landed value on fishing effort as indicated by subsequent landings is shown by table 10.

Table 10 - July-August Lobster Landings and Prices in Relation to Landings of the Following Year

Year	April-May Temperature	July-Aug. Landings	July-Aug. Price	Year	Jan.-June Landings	Jan.-Dec. Landings
	°F.	Million Lbs.	¢/Lb.		(Million Lbs.)	
1953	50.0	8.1	33	1954	3.6	21.7
1955	48.6	8.3	32	1956	3.2	20.6
1954	48.5	8.1	34	1955	3.8	22.7
1957	48.0	7.8	35	1958	4.4	21.3
1952	47.6	7.1	42	1953	4.1	22.3
1960	46.6	6.5	44	1961	4.3	20.9
1963	46.3	5.6	60	1964	-	-
1958	45.8	6.0	50	1959	4.4	22.3
1956	45.0	5.1	50	1957	4.1	24.4
1959	44.8	5.3	51	1960	4.5	24.0
1961	44.5	4.7	59	1962	3.8	22.1
1962	44.3	5.6	53	1963	4.7	22.8

Modifications of these data for use as prediction tables are shown in table 10a.

Table 10a - Tables for the Prediction of Maine Lobster Landings and Relative Abundance Based on Demand Modified by Sea Water Temperature

April-May Temperature	July-Aug. Landings	July-Aug Price	Year Following	
			Jan.-June	Jan.-Dec.
°F.	Million Lbs.	¢/Lb.	(Million Lbs.)	
50.0	8.3	32	3.2	20.5
49.0	8.2	33	3.6	21.5
48.5	8.1	34	3.8	22.0
48.0	7.8	35	4.0	22.0
47.5	7.1	42	4.1	22.5
46.5	6.5	44	4.3	22.5
46.3	6.0	50	4.4	22.5
45.8	5.8	51	4.5	22.5
45.0	5.6	53	4.5	24.5
44.8	5.3	55	4.6	24.0
44.5	5.1	57	4.7	23.0
44.3	4.7	60	4.9	22.0
Standard Error	±6.93%	±5.13%	±3.96%	±4.52%

Table 11 - April-May Sea Water Temperature (Boothbay Harbor) and Annual Lobster Landings (York County)

Year	April-May Sea Water Temperature	Change from Preceding Year	Predicted Landings	Landings
	°F.	± in °F.	Million Lbs. 1/	Million Lbs.
1962	44.3	- .2	1.4	1.5
1961	44.5	-2.1	1.5	1.5
1960	46.6	+1.8	1.7	1.7
1959	44.8	-1.0	1.4	1.5
1958	45.8	-2.2	1.6	1.4
1957	48.0	+3.0	1.7	1.8
1956	45.0	-3.6	1.4	1.5
1955	48.6	+ .1	1.5	1.6
1954	48.5	-1.5	1.5	1.5
1953	50.0	+2.4	1.4	1.6
Standard Error ±7.70%				

1/ Based on ±5% fluctuation with each °F. change in temperature.

Since supply in recent years has been inadequate to meet demand, biological and environmental factors have become increasingly critical. Demand has increased and will remain high for the forseeable future. Methods of precise prediction of future supplies will have to be based on sea water temperature with its influence on the rate of growth and recruitment and the level of fishing effort, rather than on price factors alone. With the current level of fishing intensity the effects of environmental changes on supply will become evident as deviations from predicted availability and relative abundance. Evidence of the past 13 years suggests that available abundance fluctuates approximately 5 percent with each degree of April-May temperature change.

Application of this evidence to probably the most intensive lobster fishery in Maine, that of York County, for purposes of prediction, and an evaluation of the accuracy of the predictions is shown in table 11.

EFFORT, TEMPERATURE, AND PRODUCTION

The relationship among annual landings, sea water temperature, and fishing effort is best illustrated by table 12 in which various levels of production are shown with the effort and temperature which produced them.

Table 12 - Relationship Among Annual Landings, Sea Water Temperature, and Fishing Effort

Year	April-May Temperature	No. of Traps	Landings
	°F.	1,000	Million Lbs.
1957	48.0	565	24.4
1960	46.6	745	24.0
Average	47.3	655	24.2
1953	50.0	440	22.3
1955	48.6	532	22.7
1963	46.3	731	22.8
1959	44.8	717	22.3
1962	44.3	767	22.1
Average	46.8	636	22.4
1954	48.5	488	21.7
1958	45.8	609	21.3
1961	44.5	752	20.9
Average	46.3	616	21.3
1952	47.6	417	20.0
1956	45.0	533	20.6
Average	46.3	475	20.3

With sea water temperature influencing seasonal supply and landed value influencing effort, fishermen have generally responded to changes in temperature by adjustments in effort.

Table 13 - Fluctuations in April-May Sea Water Temperature and Corresponding Changes in Fishing Effort to Maintain Constant Production, 1941-1963

Temperatures	Number of Traps
°F.	1,000
-5.7	+327
-5.2	+277
-4.4	+369
-4.3	+235
-4.2	+279
-3.9	+150
-3.8	+185
-3.7	+291
-3.7	+229
-3.1	+226
-2.7	+121
-2.6	+116
-2.3	+199
-1.7	+ 95
-1.5	+180
-1.5	+ 48
-1.4	+ 92
-1.3	+143
- .5	+219
- .5	+ 50
+ .3	+ 43
+ .4	- 7
+ .7	- 86
+1.0	- 43
+1.5	+ 14
+2.0	+ 84
+3.7	- 11

Although this relationship is less precise than it is with some other factors, it does indicate a collective response, conscious or otherwise, of fishermen to temperature fluctuations. A summary of this relationship is shown in table 13.

Since 1941 there have been 27 paired years in which landings have fluctuated 600,000 pounds or less, averaging no more than 3 percent. The relationship of declining effort to increases in temperature or relatively minor changes in temperature and of greatly increased effort to major declines in temperature is illustrated by table 13.

SUSTAINED YIELD

Examination of all the data and their relationships suggests that under existing legal and social conditions of the fishery, a sustained annual yield of 22 million pounds is possible by the proper application of this information.

Sampling of fishermen for the length of the fishing year indicates an average of 130 days. With fishing effort ranging from 383,000 to 800,000 traps and having an average 6.5 percent increase per year since 1951, despite some declines in temperature, the data from table 13 have been used to construct the graph shown in figure 5 as well as to prepare table 14.

Selected pairs of years in which average landings ranged from 21.5 to 22.5 million pounds have been used to find out what fishing effort (number of traps) has to be used at any given April-May sea water temperature level between 44.5° and 49.5° F. to produce 22 million pounds of lobster.

The curve of figure 5 represents sustained yield at 22 million pounds. Deviations as they have occurred within the limits of 21.5 to 22.5 million pounds are indicated. In those years

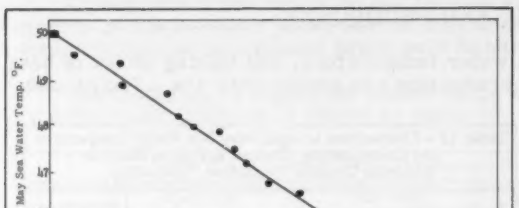

Fig. 5 - Sustained annual yield of 22 million pounds in Maine lobster fishery.

Table 14 - A Type of Management for Sustained Yield in the Maine Lobster Fishery

Years	Average April-May Sea Water Temperature	Average Lobster Landings	Number of Fishing Units (Traps) Needed to Catch 22 Million Pounds
	°F.	Million Lbs.	1,000
1951-53	49.5	21.6	421
1953-54	49.3	22.0	464
1951-55	48.8	21.8	468
1954-55	48.6	22.2	505
1949-57	48.2	21.9	516
1953-58	47.9	21.8	530
1951-60	47.8	22.4	554
1955-58	47.2	22.0	571
1952-60	47.1	22.0	581
1954-59	46.7	22.0	603
1954-62	46.4	21.9	630
1956-60	45.8	22.3	630
1958-59	45.3	21.8	675
1958-62	45.1	21.7	697
1959-61	44.7	21.6	749
1961-62	44.4	21.5	778

when average landings were greater or less than 22 million pounds, the number of traps has been adjusted up or down on a percentage basis.

This application of research findings illustrates how biological and economic information might be used to bring about the ultimate objective of conservation--sustained annual yield of a resource at the best level possible.

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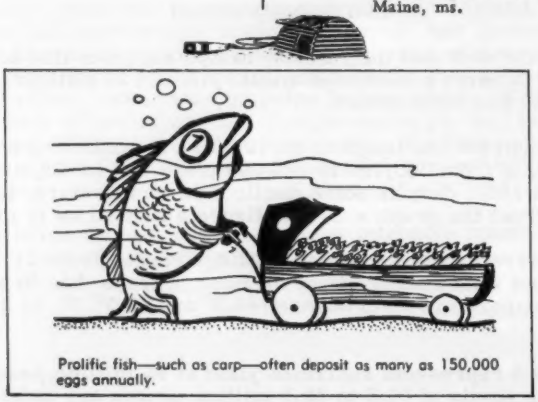

Prolific fish—such as carp—often deposit as many as 150,000 eggs annually.

TRAWLING RESULTS OF THE R/V ANTON BRUUN IN THE BAY OF BENGAL AND ARABIAN SEA

By A. T. Pruter*

SUMMARY

Trawling surveys in the Bay of Bengal and in the Arabian Sea were conducted in 1963 from the National Science Foundation research vessel Anton Bruun as part of the United States contribution to the International Indian Ocean Expedition. Relatively small shrimp catches obtained may reflect a distribution of shrimp concentrations in shallower waters than were surveyed. Demersal fish in the Bay of Bengal generally were similar to those observed in the Arabian Sea. Stingray dominated the catches in all regions at depths less than 50 fathoms.

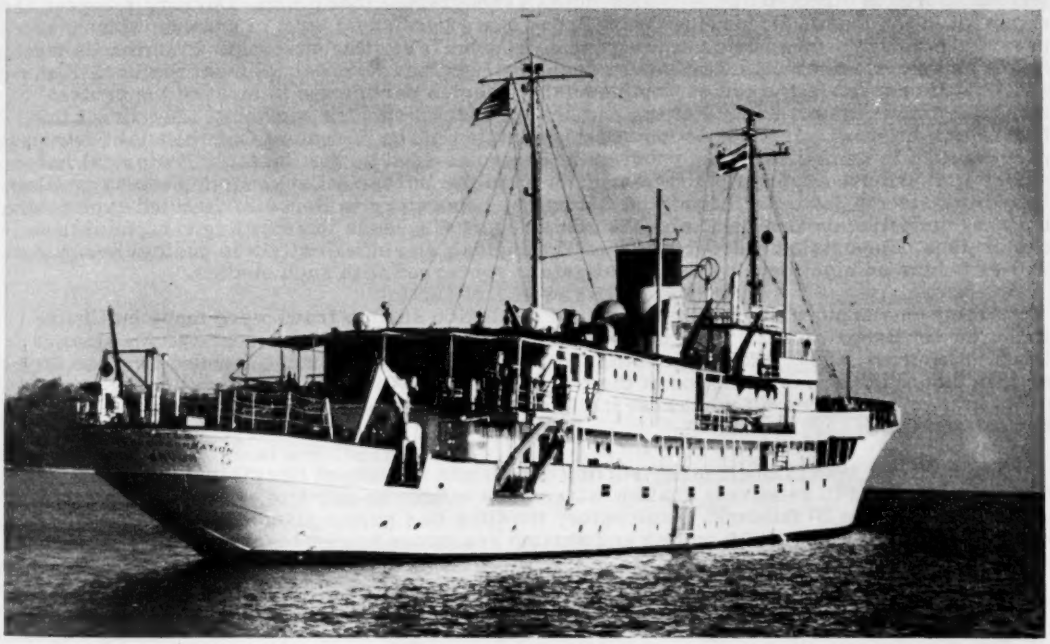

Fig. 1 - United States National Science Foundation research vessel Anton Bruun at anchor off Phuket, Thailand, during Cruise 1 in the Bay of Bengal.

Largest fish catches were taken off Muscat and Oman (Arabia). The precipitous and uneven ocean bottom at depths greater than about 100 fathoms in both the Bay of Bengal and the Arabian Sea, together with relatively few demersal fish at such depths, would seem to hinder if not preclude developing deep-water trawl fisheries.

INTRODUCTION

The International Indian Ocean Expedition (I.I.O.E.) is sponsored by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) with the cooperation of the Inter-

*Fishery Biologist, Exploratory Fishing and Gear Research Base, U. S. Bureau of Commercial Fisheries, Seattle, Wash.

national Council of Scientific Unions. It is an unprecedented, cooperative, international study of the seas, and represents the first attempt to study scientifically an entire ocean. More than 40 vessels and several hundred scientists from many nations are participating in the 3-year program. Information on the Indian Ocean will permit more accurate weather forecasting, charting sea currents, and more economical navigational routes, locating latent fisheries resources, and compiling new hydrographic charts.

From March 12 to May 10, 1963, and from November 12 to December 10, 1963, trawling surveys of the Bay of Bengal and the Arabian Sea, respectively, were conducted from the National Science Foundation research vessel Anton Bruun (fig. 1). Those surveys were part of the participation in the I.I.O.E. in which various governmental groups and educational and private institutions are participating.

The scientific program from the 243-foot Anton Bruun (formerly the Presidential yacht Williamsburg) is directed by the Woods Hole Oceanographic Institution. During its 2-year assignment in the Indian Ocean, the Anton Bruun has a permanent staff of oceanographers to provide continuity in the basic oceanographic program. Visiting scientists from the United States and other countries participate in individual cruises. Personnel from the U. S. Fish and Wildlife Service's Bureau of Commercial Fisheries participate in most of the cruises from the Anton Bruun, and on 4 of the cruises involving fisheries surveys[1/] they direct the fishing activities. Overall direction and coordination of the Bureau of Commercial Fisheries participation in the Indian Ocean program is being provided by the Bureau's Biological Laboratory in Honolulu. Scientists and fishermen from the Bureau's Exploratory Fishing and Gear Research Base at Seattle and from the Biological Laboratory in Honolulu directed exploratory trawling activities on Cruises 1 and 4B. This report discusses the trawling results of those two cruises. Reports on hydrographic, ichthyological, and other activities during the cruises will be published elsewhere by the investigators concerned with such studies.

Thirty-one exploratory hauls with a Gulf of Mexico shrimp trawl were made on Cruise 1 in the Bay of Bengal. Hauls were made off the west coast of Thailand, near the Andaman Islands, off Burma, and off East Pakistan. The trawling phase of Cruise 1 ended 1 month earlier than planned due to malfunction of the trawl winch. On Cruise 4B, 86 trawl hauls were made in the Arabian Sea off northwest India, off West Pakistan, in the Gulf of Oman, and off Muscat and Oman (Arabia).

Commercial trawl fisheries for shrimp and fish in the Bay of Bengal and in the Arabian Sea are restricted to relatively shallow waters of a maximum depth of about 40 fathoms and generally less than 20 fathoms. Exploratory trawling on Cruises 1 and 4B was primarily designed to provide information on fish and shrimp resources in regions and at depths not presently exploited.

On Cruise 1 in the Bay of Bengal the vessel track was chosen to accommodate both oceanography and exploratory fishing; on Cruise 4B in the Arabian Sea, exploratory fishing only.

GEAR AND METHODS

Nylon Gulf of Mexico shrimp trawls (Schaefers and Johnson 1957) measuring 42 feet along the footrope and having a mesh size of $1\frac{1}{2}$ inches (stretched measurement, opening including one knot) were used on both cruises. The trawl was connected by a 25-fathom-long bridle to a single towing warp. A rectangular otter board measuring $2\frac{1}{2}$ feet by 5 feet and weighing 160 pounds was attached to each wing of the net when trawling to depths of 200 fathoms. Below 200 fathoms heavier boards (260 pounds each) were used.

The shrimp trawl was towed from an A-frame on the starboard side of the Anton Brunn. A hydraulic crane located aft of the A-frame lifted the net and doors outboard and inboard and lifted the cod end of the net aboard after each haul. A "lazy line"--a nylon rope with a loop on one end passing through puckering rings on the forward portion of the cod end--was used to pull the net alongside the Anton Bruun and to lift the cod end aboard.

1/Cruises 2 and 5 are tuna surveys employing pelagic long-line gear; Cruises 1 and 4B are bottom-trawling surveys.

Echo-sounding tracings of the ocean bottom were obtained whenever the Anton Bruun was under way. They were supplemented by more detailed soundings prior to trawling and by samples of bottom sediments obtained with a small dredge or a spring-loaded bottom grab.

The Anton Bruun is powered by two main engines supplemented by an active rudder. Using the port engine the vessel moved at 6 to 8 knots during setting of the trawl. When approximately 50 to 100 fathoms of cable remained to be let out on each haul, the vessel was slowed by reducing speed of the port engine as low as possible and running the active rudder in reverse. This was done in an attempt to have the vessel proceeding at standard trawling speed when the trawl reached the ocean bottom. Either the port engine, the active rudder, or a combination of both was used to maintain trawling speed after the net reached the ocean bottom. Trawling speed ranged between 2 and $3\frac{1}{2}$ knots.

The ratio between the amount of towing warp out and the depth to bottom was greater in shallow water than in deep water, ranging from 6 to 1 (6 fathoms of cable to 1 fathom of depth) in less than 20 fathoms to approximately $2\frac{1}{2}$ to 1 at 1,000 fathoms. To ensure that the trawl reached bottom, a practice was followed of using slightly higher ratios than were found satisfactory in exploratory trawling with identical gear in the northeastern Pacific Ocean (Pereyra 1963).

Duration of the hauls varied between 30 and 60 minutes, counted as the time the net was on the bottom. Catches were emptied onto a sorting table and separated by family (genera or species when possible). Each group was examined (1) to determine the number of individuals present and their total weight, and (2) to estimate their range in length by measuring the total lengths of the smallest and largest individuals present. Length frequencies were obtained from representative samples of some groups of fishes. For the larger shrimp catches, estimates of the number of whole (heads on) shrimp per pound were recorded.

REGIONS SURVEYED

Locations of trawl stations in the Bay Bengal and in the Arabian Sea are shown in figures 2 and 3. The topography of the continental shelf (depths to 100 fathoms) in all regions surveyed was generally suitable for trawling except off Muscat and Oman and in the Gulf of Oman where numerous coral outcroppings were encountered. Green mud was the dominant bottom sediment in both the Bay of Bengal and the Arabian Sea. The continental slope was precipitous and uneven in all regions surveyed. This precluded much trawling at depths greater than about 100 fathoms.

For convenience in analyzing the distribution and relative abundance of fish and shrimp encountered, the survey regions were divided into the following areas: Andaman Islands, Thailand, Burma, East Pakistan, northwest India, West Pakistan, Gulf of Oman, and Muscat and Oman (Arabia). Areas were subdivided into the following depth intervals: 8-49 fathoms, 50-99 fathoms, 100-199 fathoms, 200-299 fathoms, and 1,000-1,099 fathoms (no trawling from 300 to 999 fathoms).

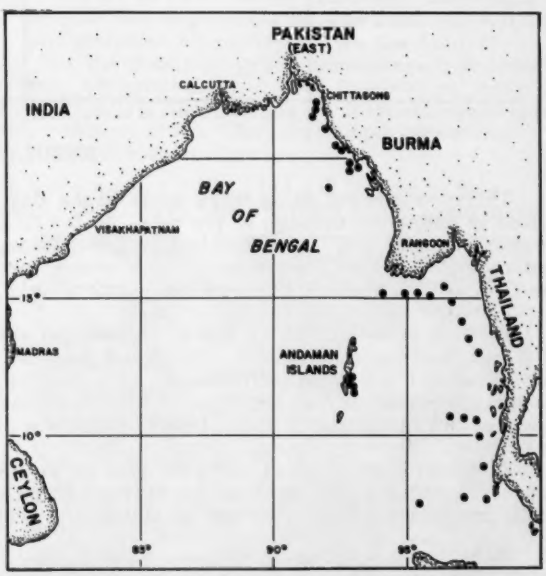

Fig. 2 - Location of trawl stations, cruise 1 of R/V Anton Bruun.

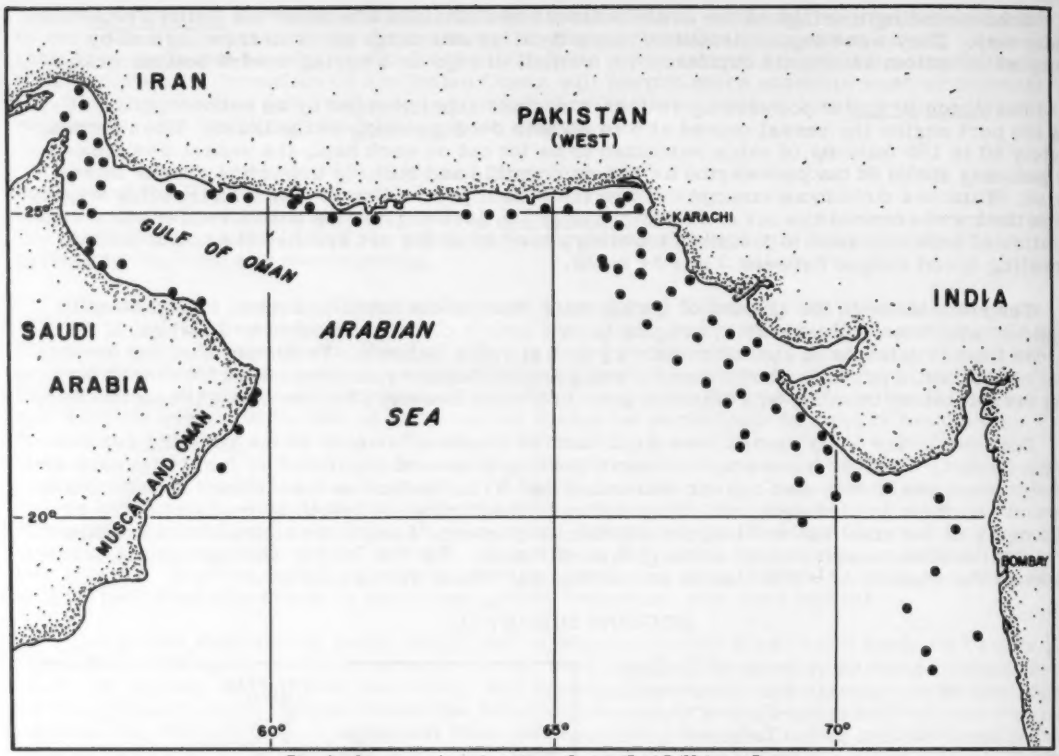

Fig. 3 - Location of trawl stations, Cruise 4B of R/V Anton Bruun.

RESULTS

Thirty-one trawl hauls were made in the Bay of Bengal; 27 were successful and 4 resulted in extensive damage to the nets. In the Arabian Sea 86 trawl hauls were completed; 77 were successful and 9 resulted in extensive damage to nets. The highest incidence of gear damage occurred off Muscat and Oman where one-half of the hauls were unsuccessful and in the Gulf of Oman where the nets were extensively damaged in one-quarter of the hauls.

Fishing effort and catch rates for fish and shrimp by areas and depth intervals in the Bay of Bengal and the Arabian Sea are shown in tables 1 and 2. Because of the few trawl hauls and the probable low catching efficiency of the shrimp trawl, it is impossible to assess the commercial potential of fish and shrimp inhabiting the various areas. The surveys do provide, however, an indication of the relative abundance of fish and shrimp between areas.

Greatest survey effort was expended in the depth range 8-49 fathoms, the shallowest zone surveyed. Within this depth range best coverage was attained off northwest India and off West Pakistan, where totals of 22 and 16 successful trawl hauls were completed (table 2).

In the depth zone 50-99 fathoms, best survey coverage was attained off northwest India, off West Pakistan, and in the Gulf of Oman where from six to seven successful trawl hauls were completed in each area (table 2).

Maximum survey effort in the depth range 100-199 fathoms was expended in the Gulf of Oman (four successful hauls) and off northwest India and West Pakistan (two successful hauls

in each region). Only one successful haul was made in the depth interval 200-299 fathoms and one in the 1,000- to 1,099-fathom interval. Both of the latter hauls were made off Burma.

Table 1 - Number of Successful Trawl Hauls, Fishing Effort, and Catch Rates by Areas and Depth Zones in the Bay of Bengal, R/V Anton Bruun, March-April 1963

Depth Interval, Fishing Effort, and Catch Rates	Andaman Islands	Thailand	Burma	East Pakistan
8-49 fathoms				
Number of hauls	2	2	12	6
Hours trawled	1.0	1.0	8.0	3.9
Pounds fish/hour trawled	58	50	107	157
Pounds shrimp/hour trawled	0	1	6	5
50-99 fathoms				
Number of hauls	1	0	0	0
Hours trawled	0.5	-	-	-
Pounds fish/hour trawled	4	-	-	-
Pounds shrimp/hour trawled	0	-	-	-
100-199 fathoms				
Number of hauls	0	0	1	0
Hours trawled	-	-	0.5	-
Pounds fish/hour trawled	-	-	68	-
Pounds shrimp/hour trawled	-	-	56	-
200-299 fathoms				
Number of hauls	0	1	1	0
Hours trawled	-	0.6	0.5	-
Pounds fish/hour trawled	-	21	80	-
Pounds shrimp/hour trawled	-	9	34	-
1,000-1,099 fathoms				
Number of hauls	0	0	1	0
Hours trawled	-	-	1.0	-
Pounds fish/hour trawled	-	-	2	-
Pounds shrimp/hour trawled	-	-	trace	-

BAY OF BENGAL: Fish: 8- to 49-Fathom Interval: Highest catch rates of fish in the Bay of Bengal occurred in the 8- to 49-fathom depth interval off Burma and off East Pakistan where 107 and 157 pounds of fish, respectively, were caught per hour of trawling (table 1). In those regions and in this depth interval, stingray (Dasyatidae) and guitarfish (Rhinobatidae) dominated the catches. Other fish which comprised an important part of the catches were drum (Sciaenidae), lizardfish (Synodontidae), and snapper (Lutjanidae). Some miscellaneous fish taken included sea catfish (Ariidae), threadfin (Polynemidae), and tonguefish (Cynoglossidae).

50- to 99-Fathom Interval: The only haul in this depth interval was made in the Andaman Islands area and was unproductive, yielding only 4 pounds of fish per hour of trawling (table 1). Included in the catch were a number of small threadfin-bream (Nemipteridae), cardinalfish (Apogonidae), lizardfish, goatfish (Mullidae), and mackerel (Scombridae).

100- to 199-Fathom Interval: The single haul in this depth interval was made off Burma and provided 68 pounds of fish per hour of trawling. Chlorophthalmid (Chlorophthalmidae) was the dominant group encountered, accounting for over one-half the total fish catch by weight. Chlorophthalmid were followed in order of abundance by scorpionfish (Scorpaenidae) and butterfish (Stromateidae). Miscellaneous species taken included bembropsid (Bembropsidae), requiem shark (Carcharinidae), grenadier (Macruridae), bigeyes (Priacanthidae), and tripodfish (Triacanthidae).

200- to 299-Fathom Interval: Single hauls were made off Thailand and Burma in this depth interval. Off Burma, hatchetfish (Sternoptychidae) were the dominant group encountered, accounting for over 70 percent of the total fish catch by weight. Hatchetfish were followed by requiem shark, grenadier, cutlassfish (Trichiuridae), and chlorophthalmids. Off Thailand, skate (Rajidae), sea robbin (Peristediidae), and boafish (Stomiatidae) dominated the catches.

1,000- to 1,099-Fathom Interval: The one successful trawl haul made in the 1,000- to 1,099-fathom interval off Burma yielded a catch rate of 2 pounds per hour of trawling. The catch consisted of one snipe eel (Nemichthyidae), four boafish, several eel larvae, and a number of unidentified fish.

The largest fish encountered in the Bay of Bengal were stingray and guitarfish which attained maximum estimated weights of 200 and 225 pounds, respectively.

Fig. 4 - Shrimp-trawl catch in Bay of Bengal, Cruise 1 of R/V Anton Bruun.

Shrimp: With the exception of the Andaman Islands area, shrimp were taken in all depth zones and in all areas surveyed in the Bay of Bengal. However, no large catches were obtained in any area. Off Burma, several individual hauls made at depths between 14 and 35 fathoms yielded from 10 to 20 pounds of shrimp per hour of trawling. Two ½-hour hauls off Burma in 165 and 200 fathoms of water yielded 28 and 17 pounds of shrimp, respectively.

Most of the shrimp belonged to the family Penaeidae (genera Penaeus and Metapenaeus) and to the tribe Caridea. They generally were small, ranging from 200 to 300 heads-on count per pound, although a few penaeid shrimp weighing over one-half pound each were caught.

ARABIAN SEA: Fish: 8-to 49-Fathom Interval: Highest catch rates of fish in the Arabian Sea occurred off Muscat and Oman in the 8- to 49-fathom depth interval (table 2) where four trawl hauls were made. Numerous coral outcroppings in that area resulted in extensive damage to the trawl nets on 2 of the 4 hauls. Of the two successful hauls, one of 30 minutes made at 23 fathoms yielded an estimated 5,500 pounds of stingray plus 100 pounds of other fish; the other (45 minutes) made at 25 fathoms yielded 1,700 pounds of fish--primarily grunt (Pomadasyidae), stingray, and cardinal fish--and 1,840 pounds of swimming crab (Portunidae).

Table 2 - Number of Successful Trawl Hauls, Fishing Effort and Catch Rates by Areas and Depth Zones in the Arabian Sea, R/V Anton Bruun, November-December 1963

Depth Interval, Fishing Effort, and Catch Rates	Northwest India	West Pakistan	Gulf of Oman	Muscat & Oman (Arabia)
8-49 fathoms				
Number of hauls	22	16	9	2
Hours trawled	16.4	11.9	6.5	1.3
Pounds fish/hour trawled	214	137	64	5,840
Pounds shrimp/hour trawled	8	trace	1	trace
50-99 fathoms				
Number of hauls	7	7	6	0
Hours trawled	5.5	6.1	4.1	-
Pounds fish/hour trawled	132	246	118	-
Pounds shrimp/hour trawled	1	1	1	-
100-199 fathoms				
Number of hauls	2	2	4	0
Hours trawled	2.0	2.0	4.0	-
Pounds fish/hour trawled	22	2	45	-
Pounds shrimp/hour trawled	trace	6	8	-

Catch rates in the 8- to 49-fathom depth interval off northwest India, West Pakistan, and in the Gulf of Oman were much lower than off Muscat and Oman, ranging from 64 to 214 pounds of fish per hour of trawling (table 2). Stingray again were dominant, accounting for from one-half to one-third of the total fish catches by weight. Other important species in all areas were threadfin-bream and drum. Grunt were numerous off West Pakistan and off Muscat and Oman. The apparent distribution of Bombay duck (Harpadontidae), a commercially important group in India, was interesting in that they were caught in substantial numbers in the Arabian Sea only off northwest India in the Gulfs of Kutch and Cambay and only in relatively shallow water (8-20 fathoms).

Fig. 5 - Catch of fish and swimming crabs taken in shrimp trawl off Muscat and Oman (Arabia), Cruise 4B of R/V Anton Bruun.

50- to 99-Fathom Interval: No trawling was conducted below 49 fathoms off Muscat and Oman. Catch rates in the depth interval 50-99 fathoms off West Pakistan and in the Gulf of Oman were higher than in the shallower interval surveyed in these regions. In contrast, off northwest India the catch rate in this interval was less than that in the shallower 8- to 49-fathom interval. Within the 50- to 99-fathom interval, stingray comprised an important part of the catches only off West Pakistan. Threadfin-bream were as important in the catches in all areas surveyed as in shallower water. Although drum and grunt were taken, they occurred less often in most areas than in the shallower 8- to 49-fathom interval. Other fish accounting for much of the catches in this interval included jack (Carangidae), sea bass (Serranidae), and lizardfish. Off West Pakistan and in the Gulf of Oman, monocle-bream (Scolopsidae) were important in the catches; however, relatively few were caught in other areas.

100- to 199-Fathom Interval: Off northwest India, West Pakistan, and in the Gulf of Oman, the catch rates declined markedly in this interval compared to those in shallower intervals (table 2). Drum and cardinalfish formed important parts of the catches in all areas. Stingray were not taken in this depth interval in any area. Off northwest India, Champsodontidae was the dominant family of fish encountered but they were virtually absent from catches off West Pakistan and in the Gulf of Oman. Threadfin-bream comprised an important part of the catches off northwest India.

The largest fish captured in the Arabian Sea were stingray, which attained a maximum estimated weight of 450 pounds. One haul made off Muscat and Oman contained approximately 5,500 pounds of stingray estimated at 40 pounds each. Occasional large guitarfish (approximately 400 pounds) were caught. Some other relatively large fish caught during the survey were false conger eel (Muraenesocidae) which ranged up to 14 pounds in weight apiece, drum of up to 22 pounds each, and threadfin of up to 15 pounds each. Many of the more abundant fish in the catches were relatively small. Grunt averaged about one-half pound and attained a maximum weight of approximately 4 pounds. Threadfin-bream averaged about one-tenth pound each. Lizardfish averaged only a few ounces, but occasional specimens ranged up to 1½ pounds. Monocle-bream, cardinalfish, and flathead (Platycephalidae) all averaged only a few ounces in weight.

Shrimp: Shrimp were taken in all depth zones and in all regions surveyed in the Arabian Sea. Catches in all regions and depth zones, however, were disappointingly small. Best catches were taken off northwest India in the 8- to 49-fathom depth interval, and in the Gulf of Oman and off West Pakistan in the 100- to 199-fathom depth interval (table 2). The largest single haul of shrimp taken in the Arabian Sea survey was 66 pounds, caught in a 45-minute haul off northwest India at a depth of 18 fathoms. The next largest single haul was 30 pounds taken in a 1-hour haul in the Gulf of Oman at a depth of 163-170 fathoms. A 40-minute haul off northwest India in the Gulf of Cambay in 15 fathoms produced 28 pounds of Caridean shrimp (Paleomon).

Most of the shrimp belonged to the family Penaeidae (genera Penaeus, Metapenaeus, and Solenocerina) and to the tribe Caridea. As in the Bay of Bengal survey, the shrimp generally were small, although occasional hauls yielded fair numbers of 40 to 50 heads-on count per pound.

Many sea snake (Hydrophidae) were caught in the small-mesh shrimp trawls in both the Bay of Bengal and in the Arabian Sea. Because they are extremely poisonous, the snakes must be handled with care when removing them from the net or from the catches. Use of larger-mesh trawls should reduce the catch of snakes.

DISCUSSION

Catching ability of the Anton Bruun may have been impaired in shallow water due to mud being stirred up from the ocean bottom by the vessel's wake. This was noticeable in depths of about 12 fathoms and less and may have frightened some shallow-water animals away from the path of the trawl. At those depths, the catching efficiency of a smaller vessel with a shallower draft might have been higher than that of the Anton Bruun.

Shrimp catches in the Bay of Bengal and in the Arabian Sea were surprisingly small in view of the large commercial shrimp fisheries there. The commercial fisheries, however, occur in shallower waters than were explored from the Anton Bruun. Shrimp appeared about equally available throughout all depth intervals surveyed out to a depth of 299 fathoms. The larger penaeid shrimp, however, were caught in the shallower depth intervals.

Largest fish catches were taken off Muscat and Oman where two successful trawl hauls in the depth interval 8-49 fathoms yielded a catch rate over 20 times as high as that obtained in any other region or depth interval. Although catches off Muscat and Oman primarily consisted of stingray and swimming crab for which there is no market, one 45-minute haul yielded 980 pounds of grunt. It seems probable that further explorations there would locate large populations of other more desirable species.

Off northwest India, West Pakistan, and in the Gulf of Oman, demersal fish appeared as abundant in the 50- to 99-fathom interval as in the shallower 8- to 49-fathom interval. Trawling effort in other areas was too inadequate in the 50- to 99-fathom interval to provide a meaningful comparison. Relative abundance of fishes at depths greater than 99 fathoms declined markedly in all areas surveyed.

Within the depth interval 8-49 fathoms in all areas surveyed, elasmobranchs, primarily stingray, dominated the catches. The relative importance of stingray in the catches decreased greatly in the 50- to 99-fathom interval and they were virtually absent in hauls made below 99 fathoms.

Demersal fish in the Bay of Bengal generally appeared similar to those observed in the Arabian Sea. In both regions, stingray, guitarfish, threadfin-bream, drum, lizardfish, threadfin, and cardinalfish were among the dominant groups encountered on the continental shelf. Grunt were important constituents of the fish fauna throughout most of the Arabian Sea; however, in the Bay of Bengal they were caught only off Burma and only in small quantities.

Throughout most of the Bay of Bengal and Arabian Sea, the precipitous and uneven ocean bottom at depths greater than 100 fathoms prevented trawling. This factor, together with an apparent reduction in abundance of demersal fishes, would seem to hinder if not preclude future development of major commercial trawl fisheries at depths greater than about 100 fathoms.

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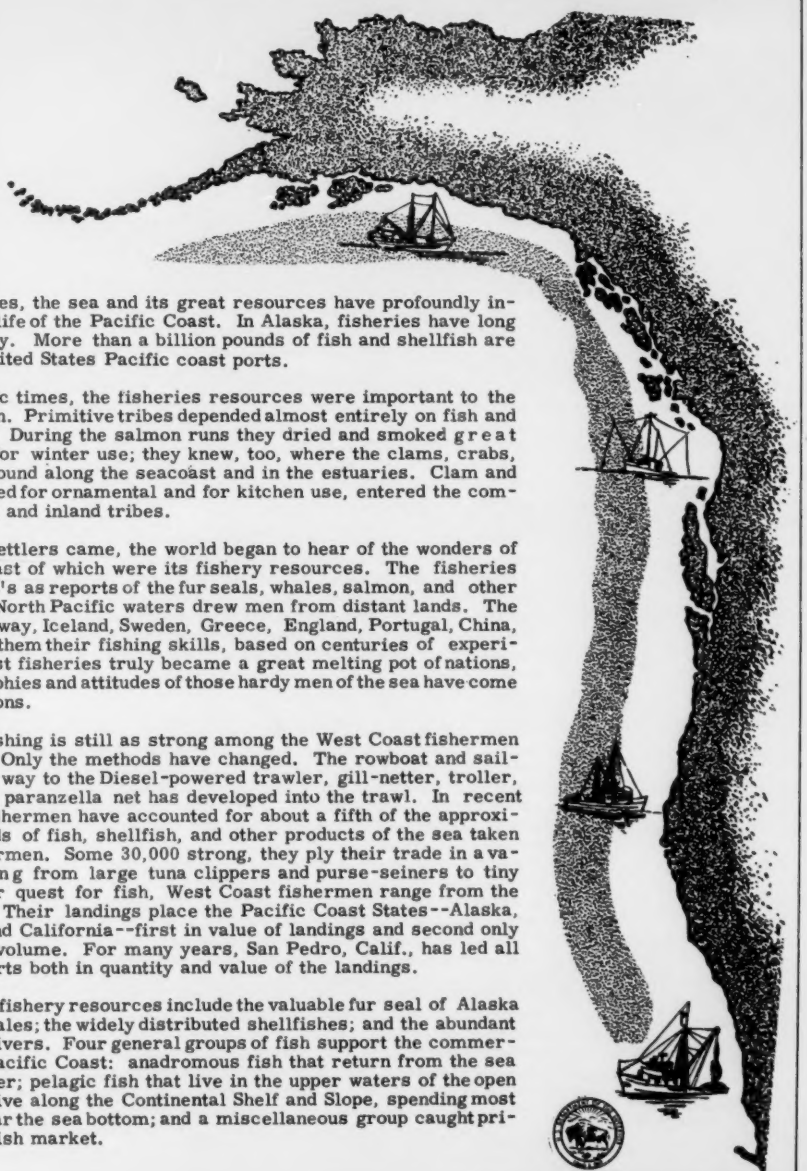
NEW WEATHER MACHINE DEVELOPED TO PREDICT WEATHER

Some of the drudgery experienced daily by the weather forecasters, and perhaps some of the vilification, may be reduced in the near future by the use of a machine, called the learning machine, which can be fed and taught to recognize geometric patterns found in weather formations.

The machine is called ADALINE (short for adaptive linear neuron) and learns its own mathematical procedures for processing meteorological data fed to it in training on weather patterns. Developed at Stanford University, the machine is now trained on some 200 weather patterns taken from weather records over the past five years and has been amazingly accurate in its predictions. (See Secrets, April 1964.)

UNITED STATES PACIFIC COAST COMMERCIAL FISHERIES



Since earliest times, the sea and its great resources have profoundly influenced the pattern of life of the Pacific Coast. In Alaska, fisheries have long been the chief industry. More than a billion pounds of fish and shellfish are landed each year in United States Pacific coast ports.

Even in prehistoric times, the fisheries resources were important to the inhabitants of the region. Primitive tribes depended almost entirely on fish and shellfish for their food. During the salmon runs they dried and smoked great quantities of salmon for winter use; they knew, too, where the clams, crabs, and abalone were to be found along the seacoast and in the estuaries. Clam and abalone shells, treasured for ornamental and for kitchen use, entered the commerce between coastal and inland tribes.

When the white settlers came, the world began to hear of the wonders of the region, not the least of which were its fishery resources. The fisheries boomed in the mid-1800's as reports of the fur seals, whales, salmon, and other species to be taken in North Pacific waters drew men from distant lands. The fishermen of Italy, Norway, Iceland, Sweden, Greece, England, Portugal, China, and Japan brought with them their fishing skills, based on centuries of experience. The Pacific Coast fisheries truly became a great melting pot of nations, and many of the philosophies and attitudes of those hardy men of the sea have come down to later generations.

The tradition of fishing is still as strong among the West Coast fishermen as in those early days. Only the methods have changed. The rowboat and sailboat largely have given way to the Diesel-powered trawler, gill-netter, troller, and purse-seiner; the paranzella net has developed into the trawl. In recent years Pacific Coast fishermen have accounted for about a fifth of the approximately 5 billion pounds of fish, shellfish, and other products of the sea taken by United States fishermen. Some 30,000 strong, they ply their trade in a variety of boats, ranging from large tuna clippers and purse-seiners to tiny fishing craft. In their quest for fish, West Coast fishermen range from the Bering Sea to Peru. Their landings place the Pacific Coast States--Alaska, Washington, Oregon, and California--first in value of landings and second only to the Gulf States in volume. For many years, San Pedro, Calif., has led all other United States ports both in quantity and value of the landings.

The Pacific Coast fishery resources include the valuable fur seal of Alaska and the far-ranging whales; the widely distributed shellfishes; and the abundant fishes of the sea and rivers. Four general groups of fish support the commercial fisheries of the Pacific Coast: anadromous fish that return from the sea to spawn in fresh water; pelagic fish that live in the upper waters of the open sea; groundfish that live along the Continental Shelf and Slope, spending most of their lives on or near the sea bottom; and a miscellaneous group caught primarily for the fresh-fish market.

--Conservation Note 15, "Commercial Fisheries of the Pacific Coast," Fish and Wildlife Service, U. S. Department of the Interior, Washington, D. C. 20240.

GOURMET'S GUIDE TO GOOD EATING

When in Seattle···

CRISPY BROILED SALMON

2 pounds salmon steaks or other fish steaks, fresh or frozen
½ cup butter or margarine, melted
¼ cup lemon juice
1 teaspoon salt
1 clove garlic, crushed
Dash paprika
1 cup crushed potato chips
½ cup crushed saltines
Lemon wedges

Thaw frozen steaks. Cut into serving-size portions and place in a shallow baking dish. Combine butter, lemon juice, salt, garlic, and paprika. Pour sauce over fish and let stand for 30 minutes, turning once. Combine crushed chips and saltines. Remove fish, reserving sauce for basting. Roll fish in crumb mixture. Place fish on a well-greased broiler pan. Drizzle sauce over fish. Broil about 5 inches from source of heat for 4 to 6 minutes or until brown. Turn carefully and broil 4 to 6 minutes longer or until brown and fish flakes easily when tested with a fork. Serve with lemon wedges. Serves 6.

Boston for Beans and-

LYONNAISE HADDOCK

2 pounds haddock fillets or other fish fillets, fresh or frozen
4 cups thinly sliced onion
¼ cup butter or margarine, melted
2 tablespoons lemon juice
1 teaspoon salt
⅛ teaspoon pepper
2 tablespoons chopped parsley
1 teaspoon crushed dill weed

Thaw frozen fillets. Skin fillets and cut into serving-size portions. Cook onion in butter until lightly browned. Place ⅓ of onion on bottom of a well-greased baking dish, 12 x 8 x 2 inches. Arrange fish over onion. Sprinkle with lemon juice, salt, and pepper. Add parsley and dill weed to remaining onion; spread over fish. Bake in a moderate oven, 350° F., for 30 to 40 minutes or until fish flakes easily when tested with a fork. Serves 6.

Appetites Ahoy!

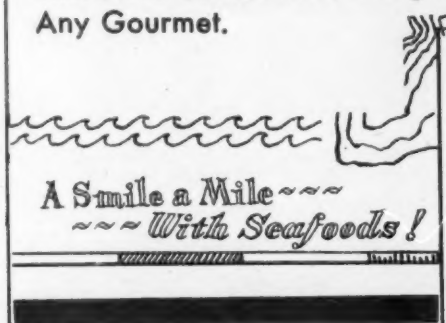
Wherever You Go in the U.S.A. There are Seafoods to Delight Any Gourmet.

It's Mighty Good in Mobile

OYSTER SANDWICH LOAVES

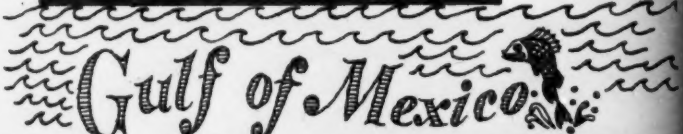
2 cans (12 ounces each) shucked oysters, fresh or frozen
6 rectangular Italian rolls
¼ cup soft butter or margarine
1½ cups dry bread crumbs
1½ cups flour
2 eggs, beaten
2 tablespoons milk
1 teaspoon salt
Dash pepper
Cocktail Sauce

Thaw frozen oysters. Drain oysters. Slice off top of each roll. Scoop out the inside to form a basket, leaving about ½ inch of crust all around. Spread inside and tops with butter. Place on a cooky sheet, 15 x 12 inches. Toast under broiler, about 5 inches from source of heat, for 2 to 3 minutes or until golden brown. Combine crumbs and flour. Combine egg, milk, and seasonings. Roll oysters in crumb mixture, dip in egg mixture, and roll in crumb mixture. Fry in hot fat at moderate heat until brown on one side. Turn carefully and brown the other side. Cooking time approximately 5 to 7 minutes. Drain on absorbent paper. Place oysters in toasted rolls. Cover with tops of rolls. Heat in a hot oven, 400° F., for 5 minutes. Serve with Cocktail Sauce. Serves 6.



A Smile a Mile~~~
~~~ With Seafoods!

From Special Fisheries Marketing Bulletin:
"A Seafood Tour of the U. S. A.,"
U. S. Bureau of Commercial Fisheries.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